Harlequin Duck Research and Monitoring in Montana: 1996

A Report to:

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ABSTRACT

In 1996, Harlequin Duck pair surveys were conducted on 100.1 km of 16 streams finding a minimum of 27♂ and 17♀. A sex ratio of 1.54:1 (m:f, n =728) was observed during 1974-1975 and 1989-1996 Montana pair surveys. Brood surveys were conducted on 325 km of 20 streams yielding a minimum of 17♀, 44 juveniles, and 3 unknowns. Breeding was confirmed for the first time on Cache Creek, Lolo National Forest (B. Duffalo pers. comm.) and the Lake Fork of Rock Creek, Custer National Forest (H. Horn, B. Horn, E. Keyser, S Reginske, and J. Cox pers. comm.) in 1996. Though Harlequins were observed as recently as 1990 or 1991 on Rattlesnake Creek, Trout Creek (Superior), and Wounded Buck Creek, no birds were seen there during 1996 pair surveys.

A minimum of 159 pairs of ducks nest in Montana representing an estimated 209 total pairs; there are currently 35 Harlequin Duck Element Occurrences known to have been occupied since 1988, however 5 of those occurrences had no ducks observed during recent surveys. There are 31 additional streams in Montana, surveyed 0-5 times each during the period 1987-1996, where Harlequin Ducks have been observed or reported but on which the breeding status is unknown.

Reproductive success, on streams surveyed both for pairs and broods in 1996, averaged 0.38 broods per female or 1.38 young per adult female; average brood size at or near fledging (Class III) was 3.64. Reproduction was below long-term average for the state and much below average for many drainages except the Sun River.

We continued banding Harlequin Ducks in the Flathead and Clark Fork drainages. During 1996, 20 adult males, 12 adult females, and 42 juveniles were captured and banded on 12 streams, bringing the total number banded since 1991 to 323 (59 males, 65 females, 199 juveniles). Cumulatively, adult males returned to their breeding streams from the previous year on 53% (n=72) of occasions, while females returned at a rate of 56% (n=108).

Through August 1996, a minimum of 24 birds banded in Montana have been sighted in Oregon (2), Washington (1), and southern British Columbia (21), including Vancouver Island and Hornby Island. Sexes and ages at banding show The following numbers and percentages of various sex and age classes (at banding) have been re-observed: adult females (6, 11%), adult males (2, 5%), juvenile females (9, 7%), and juvenile males (7, 5%).

In Montana and Idaho, several relatively long-distance movements have been documented both within and between years. Two males and several breeding females were observed using different nearby drainages during different years, indicating that movements within a drainage of up to 30 km may regularly, but rarely, occur.

Of 119 ducklings marked in 1992-94 in Montana, 18 females are known to have survived at least 2 years. Nine males marked as juveniles were seen only on the coast; none have been reported from their natal stream.

LOWER CLARK FORK POPULATION SPECIFICS

Late confirmation of funding hindered our ability to do multiple pair surveys in May, and only single surveys were done on Rock Creek, Marten Creek, Swamp Creek, and the Vermilion River. A minimum of 20 Harlequins (12 males, 8 females) were seen on 3 streams. These included Marten Creek (3 pairs plus 3♂ and 2♀), Rock Creek (3 pairs plus 1♂), and Swamp

Creek (2♂). While the numbers of birds observed on Marten Creek and Rock Creek were similar to previous years, fewer birds than normal were seen on the other two streams. Swamp Creek was surveyed somewhat early, though birds were present on the other streams; perhaps birds were simply missed. Due to road closures and a single late spring survey (1 June) no birds were seen on the Vermilion River, probably because females had begun incubation and males had left for the coast.

Brood surveys were conducted during June and July 1996. A minimum of 27 different Harlequin Ducks (8♀ and 19 juveniles) were observed on 3 streams. Summer brood surveys on Rock Creek (2 surveys) found no birds. Marten Creek had 4♀ present with 2 broods of 2 and 3 chicks (5 surveys). Swamp Creek had 2♀ present, with 2 broods of 2 and 5 chicks (4 surveys). The Vermilion River had a minimum of 2♀ present with 1 brood of 7 chicks (4 surveys).

Banding in the area was successful; additionally many previously marked birds were re-observed. Newly marked birds included 1 male from Rock Creek; 2 males, 4 young from Marten Creek, 1 male and 1 young from Swamp Creek, and 1 female and 7 young from the Vermilion River.

While no new inter-stream movements occurred here this year, a females marked as a juvenile in 1992 in Idaho was found injured and without a brood on Marten Creek in 29 July 1996. She had not been identified (she had only a USFWS leg band) on 5 previous surveys of Marten Creek in 1996; however, the earliest she may have been seen was on 3 July when a hen was spotted, but her legs were not seen. It is not known for certain if she raised a brood, since one brood had been present on prior surveys and the adult female was not observed (this also happened in 1995). It is thus unclear what the status of the female was on Marten Creek. If she survived her injuries, it will be interesting to see where she shows up next year. There have been no documented cases of females breeding on streams farther than 20 km from their natal stream (always within the same drainage) while this movement is 50 km.

ACKNOWLEDGMENTS

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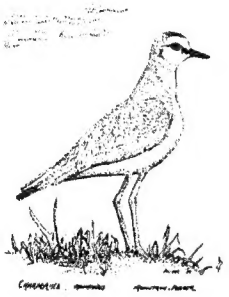

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INTRODUCTION

The Harlequin Duck (*Histrionicus histrionicus*) is a small sea duck, which travels inland to breed on fresh water streams. Harlequins breed in western North America from Alaska and the Yukon south through western Montana to California (Harlequin Duck Working Group 1993); in eastern North America, they breed from Baffin Island south to eastern Quebec and Labrador (Goudie 1993). In the Palaearctic, they breed in Iceland, Greenland and Siberia (A.O.U. 1983). Approximately 150-200 pairs of Harlequins currently breed in Montana (Reichel and Genter 1995), with most located in the following areas: 1) tributaries of the lower Clark Fork River; 2) tributaries of the North, Middle, and South Forks of the Flathead River; 3) streams coming off the east front of the Rocky Mountains; and 4) the Boulder River (Miller 1988, 1989; Kerr 1989; Carlson 1990; Fairman and Miller 1990; Diamond and Finnegan 1992, 1993; Reichel and Genter 1993, 1994, 1995, 1996).

During the breeding season, Harlequins are found along fast mountain streams (Bengtson 1966). In many areas, Harlequins use streams with dense timber or shrubs on the banks (Cassirer and Groves 1990), but they are also found in relatively open streams along the east slopes of the Rocky Mountains, Montana (Markum and Genter 1990, Diamond and Finnegan 1992), and in the Arctic tundra (Bengtson 1972). In Idaho, 90% of observations occurred near old growth or mature timber stands (Cassirer and Groves 1990). Mid-stream rocks, logs, islands, or stream-side gravel bars serve as safe loafing sites and appear to be important habitat components.

Most of the ducks arrive on their inland breeding areas in mid-April to early-May; unmated males typically arrive before pairs (Kuchel 1977). The males return to the coast shortly after the females begin incubation; most are gone by early July (Kuchel 1977). The females and young remain on the streams until August or early September. This chronology is influenced by elevation and by the timing of spring runoff; it may vary up to several weeks between years.

The U.S. Forest Service, Region 1, lists the Harlequin Duck as Sensitive (Reel *et al.* 1989). The species is listed as a Species of Special Concern by the Montana and Idaho Natural Heritage Programs (Idaho Conservation Data Center 1994, Montana Natural Heritage Program 1997). The eastern North American population is listed as Endangered in Canada (Goudie 1993).

The Montana Natural Heritage Program began surveying Harlequin Ducks in 1988. The survey data gave rise to questions involving site fidelity, productivity and mortality. We began individually marking Harlequins to a limited extent in 1991; through 1995, a total of 249 Harlequins were marked on 9 streams, representing the largest population of marked Harlequins from breeding streams. Birds marked in Montana have subsequently been captured and observed on the coasts of Oregon, Washington and British Columbia, with most reports coming from Vancouver Island (Reichel and Genter 1996). Long term goals include: 1) develop a baseline status report of current and historic Harlequin populations in Montana; 2) gather information on site fidelity, reproduction, mortality, and movements to allow estimations of what constitutes a viable Harlequin population; 3) develop survey protocols for actual and potential Harlequin streams; 4) develop management guidelines for maintaining and restoring Harlequin populations and habitat; 5) identify coastal areas where Harlequins from the Northern Rockies occur; and 6) develop a model of stream characteristics needed to support Harlequin populations. Goals for 1996 included: 1) surveying additional streams (particularly those near streams with many marked individuals) for presence and status of Harlequins; 2) gathering productivity data on

some primary Harlequin streams; 3) marking as many individuals as possible on selected streams for long-term monitoring; 4) surveying isolated streams with small numbers of ducks to begin to collect data on the long term viability of those small, local populations; and 5) summarizing status, distribution, population, movement, and survey data from Montana.

METHODS AND MATERIALS

Harlequin Ducks were surveyed on parts of the Kootenai, Helena, Deerlodge/Beaverhead, Flathead, and Lolo National Forests and in Glacier National Park during May-August 1996 (see Appendix B). Additional surveys were conducted by agency personnel of the Rocky Mountain Ranger District of the Lewis and Clark National Forest (Dave Whittekeind pers. comm.), Big Timber Ranger District of the Gallatin National Forest (Jim Sparks, pers. comm.), and Glacier National Park (Ashley 1996). Most surveys were conducted by walking the stream channel (when possible) or stream bank. In most cases, the surveyor walked upstream, giving more time to observe the bird before it moved out of sight; in cases where birds were not to be marked, the surveyor made a loop around the birds to minimize disturbance. Some larger streams were surveyed partially or completely by kayak. For streams in the Flathead and Clark Fork drainages, we attempted to capture and mark all birds seen when a licensed, qualified bird-bander was present on the survey (Reichel, Genter, or Hendricks). Captured birds were sexed, aged, weighed, measured (wing cord and tail), marked, and released. Most captured birds also had blood collected for genetic analysis by Maggie Brown (Department of Wildlife, Fish and Conservation Biology, University of California - Davis). Some adult birds outside of Glacier National Park were marked with numbered USFWS aluminum leg bands and with colored nasal discs, which are individually recognizable by shape and color combination. In all other cases, birds were banded with a USFWS aluminum band and with a blue, plastic leg band with 2 white alpha-alpha or alpha-numeric characters; these birds are individually recognizable by the imprinted characters, although the bands are less readily observed than the nasal discs. Dates, locations, distance surveyed, and general characteristics of the stream reaches surveyed were recorded; any location, number, age, and sex of all Harlequins seen was recorded, as was habitat characteristics of the site. All surveys and duck observations were entered into a database and associated ARC-INFO coverages. All data sheets used are shown in Appendix A.

In the literature and in unpublished reports, Harlequins within a geographical area are often noted as "breeding on XX number of streams." This has been variously interpreted to mean: 1) every named stream; 2) larger named streams; or 3) the major stream in an occupied drainage. Not all streams used by harlequin ducks during the breeding season are used for nesting or brood-rearing. Some streams where adult harlequins are observed may be used only during migration to and from breeding areas. In order to classify harlequin duck observations in a consistent manner we have adopted the following definitions proposed by Cassirer et al. (1996) (the first two of which would be considered "Element Occurrences" [EOs] by Natural Heritage Programs/Conservation Data Centers throughout North America).

Harlequin duck breeding occurrence:

is defined by a drainage, drainages, or portion of a drainage where breeding is known (i.e., a brood or nest has been observed within the last 15 years).

EOs are separated by either:

- A substantial barrier (>2 km over a major divide); or,
- A 10-km separation for completely unsuitable habitat (across land);
- A 20-km separation (measured along watercourses) for both rarely used habitat (lakes, <1% gradient rivers) and for apparently suitable habitat that is not known to be occupied.

Probable harlequin duck breeding occurrence:

Same definition as above, except breeding is not known, but rather is highly suspected (i.e., there have been at least 3 independent pair or female observations within the last 15 years).

Breeding status unknown:

Drainages or portions of drainages with at least 1 harlequin duck observation but fewer than 3 independent pair or female observations during the breeding season within the last 15 years.

Breeding unlikely:

Observations of males during migration periods. The male migration periods are before 15 April and after 5 June in the Northern Columbia Basin and Rocky Mountain Front areas and before 1 May and after 20 June in the Intermountain region.

Observations of pairs outside the pre-nesting season. The pre-nesting season is from 15 April - 5 June in the Northern Columbia Basin and Rocky Mountain Front areas and from 1 May - 20 June in the Intermountain area.

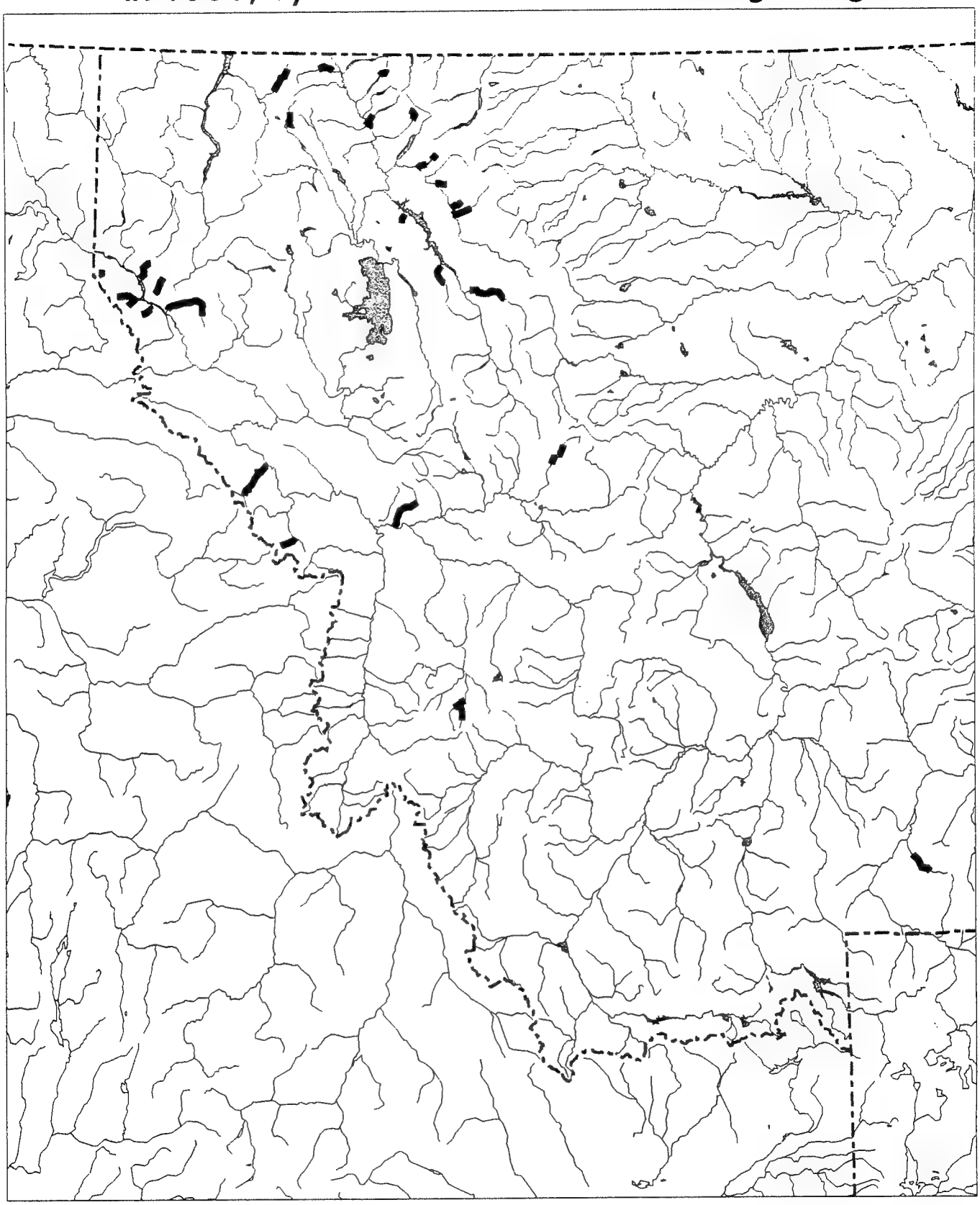
Incidental observations in unsuitable habitat such as ponds or large, low gradient (<1%) rivers not adjacent to known breeding sites, or observations on streams which have been identified as lacking breeding activity (e.g. migratory staging areas or stopovers).

SURVEYS AND BANDING

MONTANA SURVEYS - 1996

In 1996 we surveyed for Harlequin Ducks along 425 km of streams (Figure 1); in some cases those included multiple surveys of the same stream reach on different dates. Harlequin Duck pair surveys were conducted on 100.1 km of 16 streams, yielding a minimum of 27♂ and 17♀. Brood surveys were conducted on 325.0 km of 20 streams yielding a minimum of 17♀, 44 juveniles, and 3 unknowns.

Figure 1. Streams surveyed for Harlequin Ducks in Montana in 1996, by the Montana Natural Heritage Program.



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Scale in miles

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Lower Clark Fork. Pair surveys were conducted along portions of the 7 streams, totaling 99.7 km, from 1 May to 1 June 1996 (Appendix B). A minimum of 20 Harlequins (12 males, 8 females) were seen on 3 streams (Appendix C). These included Marten Creek (3 pairs plus 3♂ and 2♀; 1 survey), Rock Creek (3 pairs plus 1♂; 1 survey), and Swamp Creek (2♂; 1 survey). Marten Creek and Rock Creek had typical numbers of birds present, while few birds were seen on the other two streams. Swamp Creek was surveyed somewhat early, though birds were present on the other streams; perhaps birds were simply missed. Due to road closures and a single late spring survey (1 June) no birds were seen on the Vermilion River, probably because females had begun incubation and males had left for the coast.

Brood surveys were conducted along 152.6 km of 6 streams during June and July 1996 (Appendix B). A minimum of 27 different Harlequin Ducks (8♀ and 19 juveniles) were observed on 3 streams (Appendix C). Marten Creek had 4♀ present with 2 broods of 2 and 3 chicks (5 surveys). Swamp Creek had 2♀ present, with 2 broods of 2 and 5 chicks (4 surveys). The Vermilion River had a minimum of 2♀ present with 1 brood of 7 chicks (4 surveys). Summer brood surveys on Rock Creek (2 surveys), Elk Creek, and Trout Creek (Noxon) found no birds.

Lolo National Forest. Pair surveys were conducted along 52.9 km of 3 streams during May 1996 (Appendix B). Cache Creek had a minimum of 1 pair plus 3♂. No Harlequin Ducks were observed on Rattlesnake Creek or Trout Creek (Superior) (Appendix B); ducks have not been observed on either creek since 1991 and 1990 respectively (see DISTRIBUTION - HISTORICAL CHANGES).

Brood surveys were conducted along 20.4 km of 2 streams during August 1996 (Appendix B). The North Fork Blackfoot River had 1♀ present with a brood of 2 chicks. A summer brood survey on Cache Creek found no birds, however Bruce Duffalo reported a brood of 5 on 14 July 1996 in front of his cabin just below the confluence with the South Fork of Fish Creek (Appendix C).

Beaverhead/Deerlodge National Forest. Pair surveys were conducted along 4.6 km of the Middle Fork of Rock Creek during May 1996 and brood surveys along 12.8 km in August 1996 (Appendix B). No Harlequin Ducks were observed on either survey, however a brood was seen in 1995. It is not known whether the brood seen in 1995 was the result of a recent colonization of the stream or if birds had been there previously but had not been observed and reported. In either case, surveys should be done over the next several years to establish whether this stream will maintain harlequin occupancy.

Glacier National Park. Pair surveys were conducted along 19.2 miles of 2 streams during May and early June 1996 (Appendix B). No Harlequins were seen on either Coal Creek or Ole Creek.

Brood surveys were conducted along 49.4 km of 5 streams during July - August 1996 (Appendix B). No Harlequins were seen on any of the 5 streams. Additional pair and brood surveys were conducted by Glacier National Park personnel (Ashley 1996); reproductive parameters and movements discussed later in this report include data from Ashley (1996 and pers. comm.).

Other Northwest Montana Areas. Pair surveys were conducted along 29.5 km of 3 streams during May 1996 (Appendix B). A minimum of 19 Harlequins (11 males, 8 females) were seen on 2 streams (Appendix C). These included Grave Creek (1 pair plus 1♀) and Trail Creek (4 pairs plus 2♀ and 6♂). No birds were seen on Wounded Buck Creek where birds are known to have bred as recently as 1990 (see DISTRIBUTION - HISTORICAL CHANGES).

Brood surveys were conducted along 76 km of 5 streams during July - August 1996 (Appendix B). A minimum of 34 different Harlequin Ducks (8♀, 23 young, 3 unknown age) were observed on 4 streams (Appendix C). These included Grave Creek (2♀, 1 brood of 2 young), Spotted Bear River (3♀, 3 broods of 2, 5, and 6 young, 3 unknown age), Sullivan Creek (1♀, 1 brood of 5 young) and Trail Creek (2♀, 1 brood of 3 young). No Harlequin Ducks were observed on the Stillwater River.

Other Southwest Montana Areas. Brood surveys were conducted along 13.8 km of Mill Creek during July 1996 (Appendix B). No Harlequin Ducks were observed.

Surveys by Others. Additional surveys were conducted by Glacier National Park (Ashley 1996), on the Boulder River by the Gallatin National Forest (Jim Sparks pers. comm.), and the Lewis and Clark National Forest (David Whittekeind, pers. comm.).

SUMMARY OF MONTANA SURVEYS 1987-96

In Montana, over 3388 km of streams have been surveyed since 1987 (Reichel and Genter 1996, this report). Many of these stream reaches have been surveyed in multiple years and during both pair and brood season (Reichel and Genter 1996). Not all of these streams can be considered adequately surveyed. To be reasonably sure birds are not present on a stream where no previous sightings have occurred, at least two surveys should be conducted during the period 1-25 May; if done in a single year, surveys should be done at least 1 week apart. Due to lack of knowledge of proper survey timing, many surveys done prior to 1992 were done during June (after males have left and females are incubating) or after 10 August when many birds have left all but the streams in southwest Montana. The areas most likely to have ducks present, which need primary or additional surveys performed, are given in Appendix D.

BANDING IN MONTANA: 1991-96

During 1996 in Montana, 20 adult males, 12 adult females, and 42 juveniles were captured and banded (Table 1). This brings the total number banded since 1991 in Montana to 323 (59 males, 65 females, 199 juveniles).

Table 1. Summary of harlequin ducks marked in 1996, not including birds marked in previous years and recaptured in 1996 [unless marked on the coast and reported for the first time this year inland] (total ducks captured in all years including 1996 are in parentheses).

Location	Male	Female	Juv.	Total
McDonald Creek, Glacier NP	12 (27)	1 (29)	3 (54)	12 (110)
Waterton River, Glacier NP		1 (1)	5 (5)	6 (6)
Trail Creek	3 (10)	4 (9)	1 (15)	8 (34)
Grave Creek		2 (3)	2 (6)	4 (9)
Spotted Bear River		1 (4)	13 (28)	14 (32)
Sullivan Creek, Flathead Co.		1 (2)	4 (10)	5 (12)
Cache Creek	1 (1)			1 (1)
Blackfoot River, North Fork		1 (1)	2 (2)	3 (3)
Marten Creek, Sanders Co.	2 (15)	(6)	4 (34)	6 (55)
Rock Creek, Sanders Co.	1 (4)	(4)	(11)	1 (19)
Swamp Creek, Sanders Co.	1 (1)	(2)	1 (12)	2 (15)
Vermilion River, Sanders Co.	(1)	1 (4)	7 (22)	8 (27)
TOTAL	20 (59)	12 (65)	42 (199)	70 (323)

DISTRIBUTION

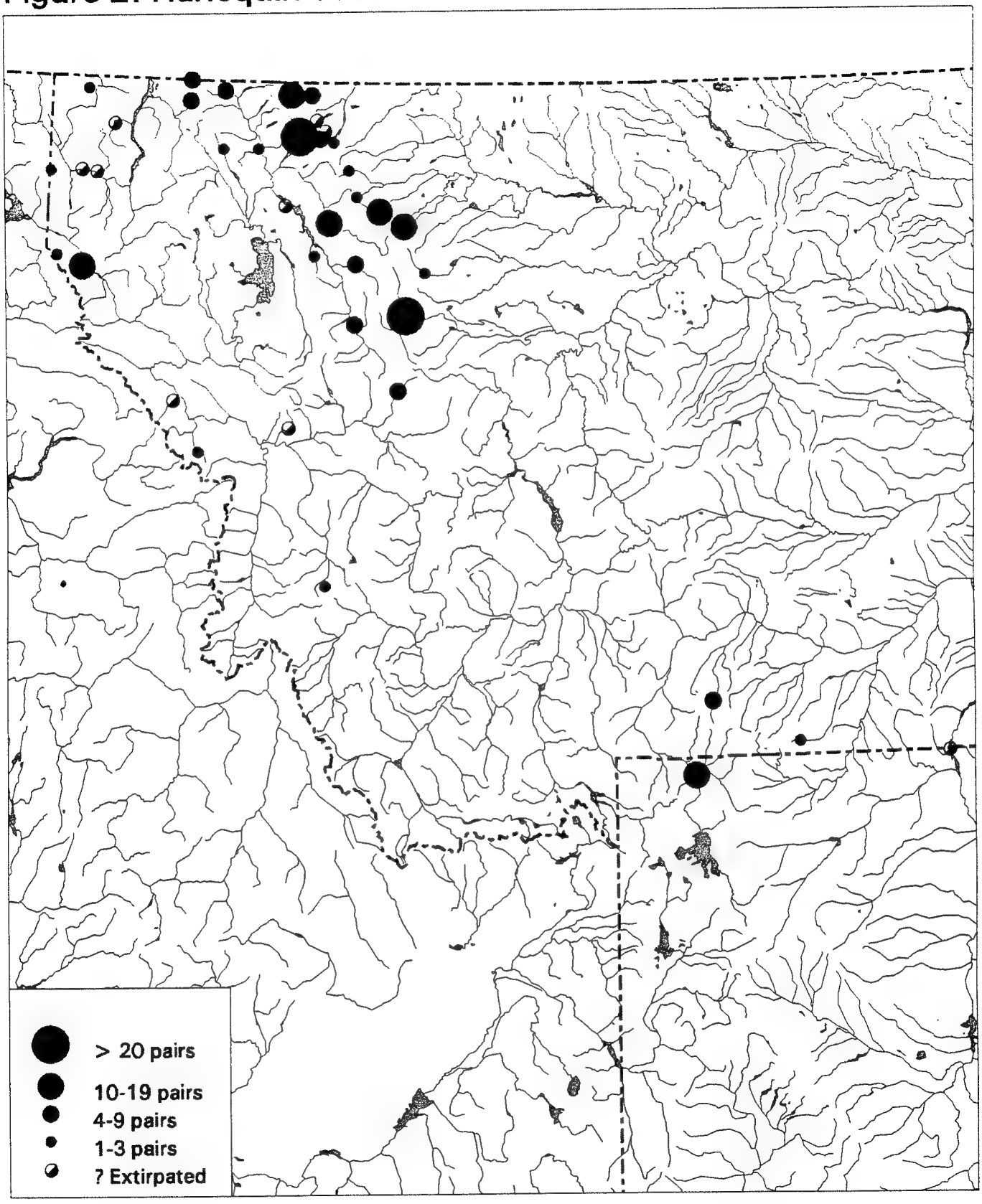
MONTANA

Breeding range. Harlequins currently breed in localized areas of western Montana (Reichel and Genter 1996) (Fig. 2). While much of Montana and Idaho has been surveyed, some areas with potential habitat have yet to be surveyed; surveying in Wyoming is less complete. As of 1996, surveys have been conducted on over 3,388 kms of Montana streams.

In Montana, there are 35 Harlequin Duck Element Occurrences (EOs - see below; Appendix D) which are known to have been occupied since 1988, however, at least 5 of those occurrences had no ducks observed during recent surveys (Table 3). Additionally there are 30 streams or stream reaches where Harlequin Ducks have been observed or reported but on which the breeding status is unknown; these streams have been surveyed a total of 0-5 times each during the last 10 years (Appendix D).

One new stream, Cache Creek, was confirmed as an EO during 1996 with the report of a pair in May and a brood in July (Appendix C). The Lake Fork of Rock Creek had a brood observed on it for the first time in 1996, making it a confirmed, rather than probable, breeding occurrence.

Figure 2. Harlequin occurrence locations and size in Montana



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Scale in miles

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In Idaho, there are currently 16 Harlequin Duck EOs, and 24 streams where Harlequin Ducks have been observed or reported but on which the breeding status is unknown; these streams have been surveyed 0-5 times each (Cassirer *et al.* 1996.). In Wyoming, there are currently 8 Harlequin Duck EOs, and 17 streams where Harlequin Ducks have been observed or reported but on which the breeding status is unknown; these streams have been surveyed 0-5 times each (Cassirer *et al.* 1996.).

Using habitat characteristics, accessibility, amount of human use, and nearby Harlequin Duck occurrences, streams were identified that had the highest potential for Harlequin Duck occurrence but for which no ducks had been observed; these included 30 in Montana (Appendix D), 16 in Idaho, and 41 in Wyoming (Cassirer *et al.* 1996). While it seems likely a few of these will be found to have Harlequin present, it seems unlikely that currently unsurveyed streams will add significant numbers to our estimate of the state-wide population.

HISTORICAL CHANGES

Within the Rocky Mountains of Montana, Idaho, and Wyoming, few historic records exist for either known current or extirpated Harlequin occurrences (Table 2, Appendix D). Prior to 1980, only 17 of the 40 Harlequin Duck occurrences in Montana were known: of those, 3 were extirpated prior to 1988 (Stillwater River in the Beartooth Mountains, Bighorn River, and Kootenai Falls) and 2 have only historic information and have not been surveyed for in recent years (Swiftcurrent Creek and Roes Creek/Otokomi Lake). The Bighorn River population was probably eliminated when Yellowtail Dam was completed in 1968, if it existed up to that time. The Kootenai River site has been developed with a popular rest area and day-use park. Pre-1980 reports of Harlequins are also known from the Jocko River, Sweet Water Creek, and Otatso Creek, but the historic information does not allow us to determine whether or not breeding probably took place on those streams, nor have sufficient recent surveys been completed to determine current status. The scant existing evidence suggests that Harlequin Ducks were once more widespread in Montana, however, the extent of loss is impossible to know.

Harlequins have not been observed during recent surveys of Big Creek, Quartz Creek, Rattlesnake Creek, Trout Creek, or Wounded Buck Creek in Montana, indicating possible extirpation (Table 3). On each of these streams, no more than a single pair or brood per year had been previously reported. All 5 streams are more than 20 km or more from any other stream known to be currently occupied by Harlequin Ducks. Additionally, the only occupied streams less than 30 km away are either: 1) over a major divide (Big Creek to West Fork Yaak River; Trout Creek to St. Joe River, ID; Wounded Buck Creek to McDonald Creek); and/or 2) have less than 3 pairs of ducks present (Big Creek to West Fork Yaak River; Quartz Creek to Callahan Creek). As one would expect, this suggests that isolated streams with small populations are very susceptible to extirpation. However, other potential factors may be involved. Both Wounded Buck and Big Creeks have had their lower reaches inundated by reservoirs and were perhaps remnants of originally larger occurrences which existed prior to dam construction. Quartz Creek, Rattlesnake Creek, and Trout Creek have residential and/or industrial development along their lower reaches; additionally Rattlesnake Creek above the development is now part of the Rattlesnake Creek National Recreation Area.

During the past 100 years, the North American range of the Harlequin Duck has undergone both large- and small-scale contractions. Historically, Harlequins bred in Colorado, probably as a small isolated population, until at least 1883 (Parkes and Nelson 1976); currently, they do not breed in the state. In Oregon, Harlequins historically bred in the Wallowa and probably Blue Mountains of the northeastern part of the state, but are no longer present there (Gabrielson and Jewett 1940, Latta 1993). They are also thought to have historically bred much more widely in the North Atlantic region (Merriam 1883, Peters and Burleigh 1951, Goudie 1989, 1993).

On a smaller scale, heavy white-water rafting is believed to have been the primary factor in the displacement and resulting extirpation of Harlequins on the Methow River in Washington (Brady pers. comm. *in* Clarkson 1994). In Yoho National Park, Alberta, Harlequins regularly bred in the vicinity of Lake Ohara until 1985; they have not been seen since (Hunt and Clarkson 1993). This area now has heavy recreational use, building facilities, and a hiking trail encircling the lake.

Table 2. U.S. Rocky Mountain streams previously used by Harlequin Ducks where no use has been documented since 1988 (Cassirer et al. 1996, this report)

State	Historical consistent use documented	Historical occasional breeding documented	Historical occasional pair use documented
Montana	Kootenai Falls area of Kootenai River (13)[2] Stillwater River of the Yellowstone (2)	Roes Creek (Otokomi Lake)	Bighorn River Canyon Jocko River Sweet Water Creek Otatso Creek (1)[2]
Idaho	Kelly Creek and N. Fork Clearwater River below Kelly Creek (3)[1]	Smith Creek (Kootenai River) (3)[1]	Orogrande Creek (N. Fork Clearwater River) (4)[1]
Wyoming			Shell Creek Canyon

[1]Number in parentheses represents the number of surveys between 1989 - 1994
[2]Number in parentheses represents the number of surveys between 1989 - 1996

Table 3. Streams in Montana where Harlequins have not been observed during recent surveys.

Stream	Last seen	Recent surveys	km to other occurrences
Big Creek (Kootenai River)	1990	1991, 93, 94, 95	30 to W.F. Yaak River 40 to Grave Creek
Quartz Creek (Kootenai River)	1988	1989, 90, 95	20 to Callahan Creek 47 to Rock Creek
Rattlesnake Creek (Clark Fork)	1991	1996	55 to Cache Creek 75 to N.F. Blackfoot
Trout Creek (Superior)	1990	1991, 92, 93, 95, 96	25 to St. Joe, ID 37 to Cache Creek
Wounded Buck Creek (S. Fork Flathead River)	1990	1992, 1996	27 to McDonald Creek 31 to Sullivan Creek

MOVEMENT

ON THE BREEDING GROUNDS

In Montana and Idaho, several relatively long-distance movements have been documented both within and between years (Table 4). The two longest movements to date were recorded in 1996. A females marked as a juvenile in 1992 was found injured and without a brood on Marten Creek in 29 July 1996 (Table 4). She had not been identified (she had only a USFWS leg band) on 5 previous surveys of Marten Creek in 1996; however, the earliest she may have been seen was on 3 July when a hen was spotted, but her legs were not seen. It is not known for certain whether or not she raised a brood, since one brood had been present on prior surveys and the adult female was not observed (this also happened in 1995). It is thus unclear what the status of the female was on Marten Creek. If she survived her injuries, it will be interesting to see where she shows up next year. There have been no documented cases of females breeding on streams farther than 20 km from their natal stream (always within the same drainage) while this movement is 50 km.

The second long distance movement was a female marked on Grave Creek on 31 July 1997 without a brood (Table 4). She was observed again, 75 km away, on McDonald Creek on 20, 22, and 28 August 1997 (Ashley 1997). This is likely either a post breeding season exploratory movement or wandering during migration. Since no surveys had been done on Graves Creek since May, it is unknown if she had spent the summer there, or if she was already moving prior to capture.

Two males and several breeding females have been observed using different nearby drainages during different years (table 4). These observations indicate that movements within a drainage, both within and between years, of up to 30 km may regularly, but rarely, occur. Movements occurred even over large reservoirs (Noxon Reservoir) and lakes (Lake McDonald). The 1995 movement by a female and her entire fledged brood to the Vermilion River (Table 4)

was likely the result of disturbance due to marking; however, the movement took place at least 4 hours following the release of the birds. The female in Glacier Park (Table 4) has been seen at several locations on different streams over the 4 years since her banding (Ashley 1995); the locations in Table 4 are maximum total known distances moved during the 4 year period.

There is little published literature regarding movement within the breeding grounds. Kuchel (1977) found that pairs used lower McDonald Creek prior to establishing home ranges higher up along the stream. Once established, pairs rarely moved more than 1-2 km, although movements of up to 8 km were recorded. Kuchel (1977) found unpaired males moved considerably more, with movements of up to 10 km recorded. In a reanalysis of Kuchel's (1977) data, Cassirer and Groves (1992) found that linear home ranges averaged 7.7 km ($SD = 2.34$) on McDonald Creek, similar to the 7 km reaches used in Idaho.

On the Bow River in Banff National Park, 5 pairs of birds were marked at what is probably a staging area or local migratory corridor (Smith 1996). Two pairs remained in a 2 km section of river where they were banded, and another remained in a 2 km stretch about 12 km downstream; one pair remained within about 6 km until the female moved about 8 km up a drainage, perhaps to breed; the final pair moved about 15 km downstream within 22 days (Smith 1996).

For 35 Harlequins marked in Iceland, Bengtson (1972) found no movement overland between breeding streams and movement of only a few km within drainages. Not only did the birds return to the same drainage, but in 22 out of 33 cases, the birds were observed within 100 m of their locations during the previous year (Bengtson 1972).

Table 4. Significant movements of Harlequins within and between years on the breeding grounds (Cassirer and Groves 1994, Reichel and Genter 1994, 1995; Ashley 1995, 1996; Cassirer pers. comm.; this report).

Sex and age	1st Date	Location	2nd Date	Location	Km moved
Adult Male	1990	Gold Creek, ID	1991	Granite Creek, ID	14
Adult Male 755-76075	5/26/93	Marten Creek, Devils Gap	4/27/95	Vermilion River, 0.1 mi above Miners Gulch	31
Juv. Female 805-90262 changed to 925-09364	8/10/92	West Gold Creek at Lake Pend Oreille, ID	7/29/96	Marten Creek, near mouth of	50
Adult Female 755-76007	8/4/92	Marten Creek, mouth of (w/ brood)	7/30/93	Swamp Creek, T25N R31W Section 9 (w/ brood)	16
Adult Female 755-76025	8/10/92	McDonald Creek above McDonald Lake (w/ brood)	6/29/95	Middle Fork Flathead River (w/ brood)	18
Adult Female 755-76013	7/28/95	Marten Creek, near mouth of (with 6 young 925-09336, 37, 38, 39, 40, 41	7/29/95	Vermilion River, near Sims Creek confluence (with same 6 young) T	26
Adult Female 925-09374	7/31/96	Grave Creek, 0.7 mi above Cat Creek	8/20/96	McDonald Creek near McDonald Falls	75

MIGRATION

Nature of migration in the species. All inland populations of the species migrate to coastal waters. A marked female seen on Granite Creek, Idaho on 17 July 1991 was relocated 13 days later off of Battleship Island in the San Juan Islands, Washington (Cassirer and Groves 1992). In Iceland, birds are thought to swim up the rivers from the coastal wintering grounds to the freshwater breeding sites (Gudmundsson 1961 *in* Bengtson 1966).

Several lines of reasoning indicate that pairs migrate to the breeding grounds together: 1) two pairs marked on the breeding grounds in McDonald Creek, Montana, have been seen, apparently paired, in the spring on Hornby Island, B.C., prior to migration (Ashley pers. comm.); 2) one bird of a pair is not seen prior to the arrival of the other - they are seen for the first time together; and 3) there are no records of lone males observed later paired during the same year.

Sibling juveniles may migrate together to the coast, as indicated by the presence of 3 siblings at Hornby Island, B.C., which were marked together 7 months earlier on Swamp Creek, Montana. Whether females and their broods migrate together in some instances is unknown. However, it is known that females occasionally leave prior to their young fledging. In Montana, out of 113 broods observations during 1988-96, 14 broods (12%) were found without the hen prior to migration (this report, Ashley pers. comm.). Age class of the 14 abandoned broods when

they were first observed alone were as follows: 2 were Class I, 2 were Class II, 3 were Class III, and 7 broods were first observed without the adult female following fledging. In one additional case, a brood of 7 was marked with the female on 11 Aug 1992; on 2 September the female was seen with 5 of her fledged juveniles, while one of the brood was observed alone 2.5 km away.

Timing and routes of migration. Of 249 Harlequins banded in Montana from 1991-1995, a minimum of 24 have been reported from Oregon (2), Washington (1), and southern British Columbia (21), including Vancouver Island and Hornby Island through September 1996. Sexes and ages at banding show the following numbers and percentages observed: adult females (6, 11%), adult males (2, 5%), juvenile females (9, 7%), and juvenile males (7, 5%). We have not included records from birds marked in Montana during 1996, nor any birds seen following migration to the coast in 1996-97, since data will be incomplete until late April 1997. Only 4 other records of migration exist from the Rocky Mountain states. Two females radio-marked in Idaho were located in the San Juan and Gulf Islands of Washington and British Columbia, while one banded bird was reported from northwestern Washington (Cassirer and Groves 1994). The only known wintering bird marked in Wyoming was observed off of San Juan Island in Washington in August 1989; he returned to Grand Teton National Park as an unpaired male in 1990 (Cassirer and Groves 1991, Wallen 1993).

Some evidence of staging areas on the breeding grounds exists. Some marked harlequins observed in early spring on McDonald Creek, Montana, disappear almost immediately (Kuchel 1977, Ashley pers. comm.); these may be going to different drainages in the vicinity. At Kootenai Falls, Montana, in the early 1980s, only 1 pair bred in the immediate vicinity, while up to 6 other adults appeared to loaf there prior to and following the breeding season (Thompson 1985, Genter unpubl. data).

Harlequins, typically unpaired males, begin to arrive in Montana in mid-April (Kuchel 1977, Ashley 1994); the earliest record for Glacier National Park is 4 April 1970, on the Middle Fork Flathead River (Kuchel 1977:32). Pairs in Montana begin to arrive in late April, and most are present by early May (Kuchel 1977, Ashley 1994, Reichel and Genter unpubl. data). Two-year-old females may arrive later than older females (Ashley 1994, Kuchel 1977:32); this age group may be the unpaired females that Wallen (1987) reported as arriving about 4 weeks later than pairs and then not breeding. Males begin leaving Montana by late-May, and are typically gone by late June (Kuchel 1977, Reichel and Genter 1993, Ashley 1994). Females begin leaving by early July if breeding is unsuccessful, and otherwise by mid-late July. Juvenile birds leave last, beginning in late July, and both adult females and juveniles are gone by the beginning of September (Ashley 1994, Reichel and Genter unpubl. data).

In Washington, birds arrive on breeding streams in late March or early April (Schirato 1993). In Oregon, birds arrive on the breeding streams in late April, although some have been reported as early as late February (Latta 1993).

There are few records of birds stopping between their breeding areas and wintering areas. A single marked bird has been observed en route from wintering to breeding grounds. She was originally marked in Wyoming and observed on the way back to the breeding stream on Crooked Creek, South Fork Clearwater River drainage, in central Idaho and seen about a week later in Grand Teton National Park (Cassirer and Groves 1991, Wallen 1993).

Migratory behavior. It is believed that nearly all one-year-old birds, and some (perhaps most) two-year-old birds remain in coastal water, not moving to breeding streams until they are 2-4 years of age. The proportion of each age class which stays on the coast has yet to be

determined, but indications are that perhaps ½ of 2-year-old females and ¼ of 3-year-old females do not return to the breeding grounds (see DEMOGRAPHY AND POPULATIONS: MEASURES OF BREEDING ACTIVITY - *Age at first breeding; intervals between breeding*). Wallen (1987) reported that a 1-year-old female (n=11) returned to Upper Moose Creek, her natal stream in Grand Teton National Park in 1986. This is the only report of a 1-year-old female on the breeding grounds. No one- or two-year-old males, out of 246 observations of males, have been seen in Montana during 1992-96 surveys (Table 7, Ashley pers. comm.).

DEMOGRAPHY AND POPULATIONS

MEASURES OF BREEDING ACTIVITY

Age at first breeding; intervals between breeding. Only a single known-aged male has been seen with a mate; it was marked as a juvenile in 1992 on Mineral Creek, Montana, and observed by J. Ashley paired with a female (white NH) at Hornby Island, BC, in March 1996. Adult male breeding plumage is attained at three years of age (Phillips 1925). No one- or two-year-old males, out of 246 independent male observations, have been observed in Montana during 1992-96 surveys (Table 7, Ashley pers. comm.). Very few, if any, 1 or 2-year-old males have been reported on the breeding grounds in North America. Yearling males make up 1-2% of the population on the breeding grounds in Iceland (Bengtson 1972, Gardarsson 1979).

The youngest female known to have bred is a 2-year-old which raised a brood of 3 in 1994 on Trail Creek, Montana; 9 additional non-breeding (or not successfully breeding) 2-year-olds have been observed on natal streams and 20 marked 2-year-olds are known to have been alive. Only a single 3-year-old has bred successfully (on Marten Creek in 1995); 8 additional non-breeding 3-year-olds have been observed on natal streams, and 16 marked 3-year-olds are known to have been alive. Only a single 4-year-old has bred successfully (on Marten Creek in 1996); 9 additional non-breeding 4-year-olds have been observed on natal streams, and 11 marked 4-year-olds are known to have been alive. Ages of females when first seen on the breeding grounds have included 2-year-olds (10), 3-year-olds (4), and 4-year-olds (2); females seen on the wintering grounds, that have not yet been seen on the breeding grounds, included 1-year-olds (2), 3-year-olds (3) and 4-year-olds (1). Since we began marking juveniles in 1992, the oldest known-age birds in 1996 were 4-year-olds. In Iceland, Bengtson (1966) believed that 2-year-old females Harlequins did not regularly go to the breeding grounds; this was conjecture, and not based on known-age birds.

Some females on breeding streams apparently, however, do not lay eggs (Bengtson and Ulfstrand 1971, Dzinbal 1982, Wallen 1987, Cassirer and Groves 1991). Bengtson and Ulfstrand (1971) examined of ovaries of 6 non-breeding females and reported that none had lain eggs. They reported that 15-30% (n=48) of adult (by bursae inspection) females were non-breeders. Many of these non-breeding "adults" may have been young (2-3 year-old) birds, since cloacal examination gives adult status to 2-year-olds. Dzinbal (1982) estimated that 53-95% of females not producing broods did not attempt to breed; those results may have been due to use of patagial markers which negatively affected breeding behavior (Bustnes and Erikstad 1990). Wallen (1987) reported that some females left the breeding stream at the same time as their mates; unpaired females arrived about 4 weeks later than pairs, did not breed, and left after 3-5 weeks.

Annual and lifetime reproductive success. Reproductive success was below average in Montana in 1996, with one of the lowest numbers of broods and young per female ever recorded on many streams outside of the Sun River drainage (Table 5, 6). In Montana during 1974-1975 and 1989-1996, annual numbers of ducklings fledged per adult female averaged 1.38 and ranged from 0.13 - 3.15 (n=349 adult females) (Table 6). Average annual brood size (IIb to fledging [aging diagram in Cassirer and Groves 1994]) averaged 3.64 and ranged from 2.00 - 5.86 (n=132 broods) (Table 6). Actual brood sizes (all ages combined) ranged from 1-9.

These numbers are also typical for most other areas. In Idaho, annual numbers of ducklings fledged per adult female ranged from 0.7 - 1.3 and averaged 1.2 (n=14); number of females producing broods was 29% in 1990 (Cassirer and Groves 1991, 1994). Average brood size was 3.4 (range 1-7) in Idaho (n=24) (Cassirer and Groves 1991). Broods ranged from 1-6 in Oregon and averaged 2.7 (n=26) (Thompson *et al.* 1993, 1994). These sightings, however, were spread throughout the breeding season and therefore should not be considered the same as numbers fledged. In British Columbia, 41 broods of all ages ranged in size from 1 - 10 (1 young (Y)-3 broods, 2Y-3, 3Y-5, 4Y-11, 5Y-14, 6Y-2, 7Y-1, 8Y-1, 10Y-1); the brood with 10 young was apparently from a single female (Campbell *et al.* 1990). In Alaska, numbers of young per breeding female and per adult female were respectively 1.5 and 0.8 in 1979, and 0.6 and 0.3 in 1980; patagial tags on adults appeared to have caused poor reproductive success (Dzinbal 1982). Non-breeding frequency of females was 47% in 1979 and 50% in 1980 (Dzinbal 1982). In Iceland, 1.73 (85:49) and 2.43 (120:49) young per adult female were successfully raised during 1975 and 1976, respectively (Gardarsson 1979). In an increasing population in Iceland, productivity ranged from 0.1 to 3.3 ($x = 1.1$) ducklings fledged per hen per year over 15 years (Gardarsson and Einarsson 1991). These results were similar to those of Bengtson (1972), who reported 0.0 to 3.8 young per adult female on 4 rivers during 4 years.

Until data are available on age-specific reproduction and longevity, no lifetime reproductive success can be calculated.

Proportion of total females that rear at least one brood to nest-leaving. Harlequin Ducks raise only a single brood each year. The proportion of females successfully raising a brood in a single year varies widely between years. In Montana during 1996, only 32% of 44 females successfully raised a brood (Table 5); stream surveys between 1974 and 1996 found that 349 females raised 132 broods for an average of 37.8% (range 7-55%) (Table 6). From throughout their range, the percentage of females which successfully raise a brood varies from 7-56% (Bengtson and Ulfstrand 1971, Kuchel 1977, Wallen 1987, Cassirer and Groves 1991, this report).

Table 5. Harlequin Duck reproduction in 1996 for Montana streams with both pair and brood (at fledging) surveys.

Stream	#Adult Females	#Broods	#Young
Flathead Drainage			
McDonald Creek[@]	19	2	7
Trail Creek	4	1	3
Drainage Total	23	3	10
0.13 Broods per adult female			
0.43 Young per adult female			
3.33 Young per brood			
Lower Clark Fork Drainage			
Marten Creek	5	2	5
Rock Creek	3	0	0
Swamp Creek	2[#]	2	7
Vermilion River	2[#]	1	7
Drainage Total	12	5	19
0.41 Broods per adult female			
1.58 Young per adult female			
3.80 Young per brood			
Other			
Sun River	6	5	25
Cache Creek*	1	0	0
Middle Fork Rock Creek	0	0	0
Grave Creek	2**	1	2
Sub-Total	9	6	27
0.66 Broods per adult female			
3.00 Young per adult female			
4.50 Young per brood			
GRAND TOTAL	44	14	56
0.24 Broods per adult female			
0.82 Young per adult female			
3.44 Young per brood			

[@] from Ashley (1996)

* D. Whittekeind, Lewis and Clark NF (pers. comm.)

** Probably an underestimate

Table 6. Harlequin Duck reproductive parameters 1974-75 (Kuchel 1977) and 1989-1996.

Year	# adult females	# broods	# young	broods per ad. female	young per ad. female	young per brood
1974	11	3	12	27%	1.09	4.00
1975	15	1	2	7%	0.13	2.00
1989	13	7	41	54%	3.15	5.86
1990*	31	17	65	55%	2.10	3.82
1991*	37	9	31	24%	0.84	3.44
1992*#	71	39	132	55%	1.37	3.38
1993#	49	21	59	43%	1.20	2.81
1994#	30	10	40	33%	1.33	4.00
1995#	48	11	42	23%	0.87	3.82
1996 *#	44	14	56	32%	1.27	3.44
Total	349	132	480			
Mean				37.8%	1.38	3.64

* includes data from the Rocky Mountain Front (Diamond and Finnegan 1992, 1993; D. Whittekeind, pers. comm.)

includes data from Ashley (1994a, 1994b, 1995, 1996)

Sex ratio. During the spring pair season, a sex ratio of 1.54:1 has been observed in Montana (m:f, n =728) (Table 7). Table 7 is based on independent male observations during the period 27 April - 30 May; when more than one survey was done during a single season on a single stream, the survey with the maximum number of females was included in Table 7. Cassirer (1995) found a spring adult sex ratio of 1.31:1 (m:f, n = 81) in 1995 on Idaho streams. In Banff National Park, Alberta, sex ratios varied from 1.37:1 in May to 1.81 in June (Smith 1996). In Iceland, sex ratios on the breeding grounds varied from 1.17 - 2.33:1 during 5 summers in late May - early June (Bengtson 1966, Bengtson 1972, Gardarsson 1979). In coastal British Columbia, the apparent sex ratio is 1.5:1 (544 birds) in winter, declining to 1.4:1 (297 birds) in March-April (Campbell *et al.* 1990); this grows to 4.3:1 in May, and by July, when adult females are still on the breeding streams, it reaches 18.2:1 (1633 birds).

Table 7. Sex Ratios of Harlequin Ducks on Breeding Streams during pair season in Montana.

Location	# Males	# Females	Year (s)	Citation
Montana (NW)	10	4	1990	Fairman and Miller 1990
Montana (NW)	1	1	1991	Lee and Genter 1991
Montana (NW)	1	1	1989	Miller 1989
Montana (RMF)	50	26	1991	Diamond and Finnegan 1992
Montana (RMF)	44	30	1992	Diamond and Finnegan 1993
Montana (RMF)	10	6	1996	D. Whittekeind (pers. comm.)
Montana (SW)	6	3	1990	Markum and Genter 1990
Montana (NW)	14	12	1990	Carlson 1990
Montana (NW)	11	6	1989	Fairman, Genter and Jones 1989
Montana	38	23	1996	this report
Montana	37	23	1995	Reichel and Genter 1996
Montana	27	17	1994	Reichel and Genter 1996
Montana	19	12	1993	Reichel and Genter 1996
Montana	10	8	1992	Reichel and Genter 1996
Glacier NP	19	18	1993	Ashley 1994a
Glacier NP	29	27	1994	Ashley 1994b
Glacier NP	35	25	1995	Ashley 1995
Glacier NP	32	19	1996	Ashley 1996
Glacier NP	22	11	1974	Kuchel 1977
Glacier NP	26	15	1975	Kuchel 1977
TOTAL	441	287		

LIFE SPAN AND SURVIVORSHIP

In Montana, 249 Harlequins (39 adult males, 53 adult females, 157 juveniles) have been banded from 1991 through 1995. Through August 1996, adult males returned to the breeding streams where they were found during the previous year on 53% (38 of 72) of occasions, while females returned at a rate of 56% (61 of 108). The higher female rate may be due to the fact that a male may mate with a new female, which could lead him to a new stream, so that he would not likely be seen on the previous year's stream. Looked at another way, 60% of males (25 of 42) and 64% of females (36 of 56) returned at least 1 year following marking. Of females marked as adults through 1994 (n=41), 6 had a gap of one breeding season between resightings on the breeding grounds (one bird had 2 gaps of 1 year); none marked through 1993 (n=36) had a two season gap. However, a single adult female marked in 1992 had never returned to the breeding grounds but was resighted on the wintering grounds in both 1995 and 1996. In 7 cases (n=30), males marked as adults through 1994 had a gap of one breeding season between resightings, and in 1 case (n=23 through 1993), a two season gap.

Of 58 juveniles marked in 1992, at least 17 females and 5 males were known to be alive in 1994, 12 females and 4 males in 1995, and 11 females and 3 males in 1996. Of 42 juveniles marked in 1993, at least 1 female and 1 male were alive in 1995, and 1 male and 1 female in 1996. Of 19 juveniles marked in 1994, no birds are known to be alive past 1995. All males marked as juveniles, and known to be alive for all years, were seen on the wintering grounds only.

In Glacier National Park, all mortality of ducklings (through fledging) took place in the first three weeks of life (Kuchel 1977). This is similar to the findings of Bengtson (1966, 1972), who reported that of 7 broods totaling 37 ducklings, 24 survived one week, and 19 survived two weeks; little mortality was seen after two weeks. Bengtson (1972) reported that survival of ducklings ranged from 40-76% on 3 streams over 5 years. An example of limited mortality after 1-2 weeks is a brood of 5 Class IB young (8-15 days-old), which was first seen on Marten Creek, Montana, on 10 July 1995, without an adult female present. All survived and were nearly flying on 28 July 1995.

In Idaho, 63% of adults (n=30) returned at least 1 year; male and female rates were not significantly different (Cassirer and Groves 1994); one duck marked as an adult in 1988 returned through 1993 (minimum 7 years old). No ducklings marked from 1988-1991 were re-observed (n=27). In Wyoming, 40% of marked adults returned to breeding streams (Wallen 1993). At least 5 females of 103 ducklings banded in 1987-1990 have returned and nested successfully (Wallen 1991). The oldest known Wyoming bird was marked as a duckling in 1985 and recaptured in 1991 (Wallen 1993). In Alaska, 30% (8) of adult females and 30% (3) of adult males marked were relocated the following year (Dzinbal 1982:62).

In Iceland, 64% (20) of adult females and 48% (13) of adult males, marked with nasal discs, were relocated the following year (Bengtson 1972). Hatching success in Iceland averaged 87%, and ranged from 84% to 91% in four years (Bengtson 1972).

RANGE

Dispersal from natal stream. In Montana, juveniles apparently leave the natal stream soon after fledging. At least 13 broods fledged prior to leaving the breeding stream (n=79) and many more may have waited that long, but follow-up surveys were not done. In McDonald

Creek, Montana, Kuchel (1977) reported that at least one brood had left prior to fledging, apparently swimming across McDonald Lake and drifting downstream. In Alaska, one brood was reported to use Stellar Lake when very young, moving down to Stellar Creek when older, and finally using Stellar Bay and the lower tidal portion of Stellar Creek when Class IIc-III (Dzinbal 1982).

Fidelity to natal stream. Of 119 ducklings marked in 1992-94 in Montana, 18 females are known to have survived at least 2 years. Of the 18 surviving females, 11 were reported only from their natal stream, 2 only from the coast, and 5 from both the coast and the natal breeding stream. Seven males marked as juveniles (1992-94) were seen only on the coast; none have been reported from their natal stream (Ashley 1995, this report). In Glacier National Park, 2 of 5 ducks banded as juveniles in 1974 returned to the natal stream in 1976; both were females (Kuchel 1977).

No ducklings marked from 1988-1991 in Idaho have been re-observed (n=27) (Cassirer pers. comm.). However, a duckling marked in Idaho in 1992 was found on Marten Creek, Montana, in 1996; it is not known if she attempted to breed there (See MOVEMENT - ON THE BREEDING GROUNDS).

Adult fidelity to breeding stream. In Montana, 4 of 5 males marked as adults and later seen on the wintering grounds returned to the breeding grounds the following year. A single female (n=47), marked on McDonald Creek in 1992 and not seen there since, was observed on Hornby Island, British Columbia, in March of 1995 and 1996. Given the intensive survey effort in Montana during that period (Reichel and Genter 1996), it is likely that she has substantially shifted her breeding location since being originally marked. This case constitutes the only evidence that breeding streams may be abandoned.

POPULATION STATUS

Estimates or counts of density. In Montana, pair density on all streams range from 0.03 pairs/km on the Teton River up to 0.80 pairs/km in the McDonald Creek drainage; the average across Montana is 0.33 pairs/km (Appendix F). Lengths were measured from the highest known observation on each stream to lowest within an occurrence; number of birds used were as in Appendix E (see POPULATION STATUS - ***Numbers***) These densities do not include the Yellowstone River complex which occurs primarily in Wyoming, several streams where ducks have not been seen in recent surveys, or several streams where too little is known to determine either the length of occupied stream or the number of pairs present. While the density is similar to, or even slightly higher than, Idaho, these densities are less than those found throughout most of the Harlequin's range. Reported densities of Harlequins on breeding streams worldwide vary from 0.03 pairs/km on the Teton River along the Rocky Mountain Front of west-central Montana (this report) to 8.5 pairs/km on part of the Laxa River in Iceland (Bengtson and Ulfstrand 1971).

In Idaho, pair densities averaged 0.19/km (range 0.08-0.57) of occupied streams surveyed (Cassirer 1995). From 1990 through 1992, densities there averaged 0.06-0.53 pairs/km ($\bar{x}$ = 0.22) (Cassirer 1993). In Oregon, densities of adults per km surveyed ranged from 0.07 to 1.21; densities per km surveyed including juveniles ranged from 0.07 to 2.37 (Thompson *et al.* 1993, 1994).

On the Bow River in Banff National Park, densities observed were the highest known from streams in North America, ranging from 2.4 ducks/km on a 15 km reach to 6.2 on a 16 km

reach (Smith 1996). On Kodiak Island, Alaska, density of breeding Harlequin pairs ranged from 0.63 pairs/km along the Ayakulik River to 1.98-7.24 birds/km in 3 coastal bays (Zwiefelhofer 1994). Dzinbal (1982) reported 1.3-1.8 pairs/km on two small coastal streams in Alaska. On the Laxa River in Iceland, Harlequins are apparently present at densities higher than other known stream populations (Bengtson 1972). Twenty populations in Iceland ranged from 0.2 to 8.5 pairs/km, with an average of 0.9 pairs/km (Bengtson and Ulfstrand 1971, Bengtson 1972). In eastern Siberia, Kistschinsky (1968 *in* Bengtson 1972) found 1.1 pairs/km and 0.8 - 1.2 broods/km.

Numbers. Numbers estimated by most recent publications and reports are listed in Table 8. Cassirer et al. (1996) reported that the maximum percentage of pairs observed during surveys done under optimal conditions was 69%. This is similar to the 75% (range 67-81%) reported by Ashley (pers. comm.) on McDonald Creek during 1993-1996. Estimated pair numbers for Montana (Table 8) were calculated using 72%. However, that percentage was not used to adjust minimum numbers on streams when a high proportion of ducks were individually marked and multiple surveys took place in several years; in those cases 90% was used. A minimum of 159 pairs of ducks nest in Montana, which represents an estimated 209 total pairs (Table 8, Appendix E).

The largest single reported Harlequin Duck occurrence (see ***Breeding Range***) is from the Bow River drainage in Banff National Park, Alberta, where, using a mark/resight model, 215 individuals were calculated to occur during 1995 (Smith 1996). In the northern Rocky Mountains of the U.S., the largest single occurrence is in the McDonald Creek drainage of Glacier National Park where an estimated 41 pairs reside. Most known occurrences in Montana are small, with only 2 having more than 20 pairs (Figure 2).

Table 8. Estimated numbers of Harlequin Ducks.

Location	Estimated Breeding Population	Minimum # Pairs	Estimated # Pairs @	Citation
Atlantic Ocean	10,000			
Greenland	5,000			Montevecchi et al. 1995
Iceland	3-5,000			Montevecchi et al. 1995
North America	<1,000			Goudie 1991
Pacific Ocean (Asia)	50-100,000			Goudie et al. 1994
Russia	50-100,000			Goudie et al. 1994
Japan	<100			Brazil 1991
Pacific Ocean (North America)	165,000			Goudie et al. 1994
Lower 48 U.S. States	2,424	571	808	
Washington		274	399	Schirato 1994
Montana		159	209	this report
Oregon		50	72	Thompson et al. 1993
Idaho		48	70	Cassirer et al. 1996
Wyoming		40	58	Cassirer et al. 1996

@ After Cassirer et al. (1996) except for Montana (see text)

Trends. Little long or short term data are available. In Montana, the long-term trend appears to be downward. Occurrences with larger populations (>5 pairs) appear to be stable over the last 4-8 years, while some small occurrences appear to be declining or were recently extirpated (see DISTRIBUTION - HISTORICAL CHANGES). In general, the recent North American Pacific population trend appears to be declining. Christmas bird counts in British Columbia show declines at 5 locations and increases at 3; the increases, however, may be due to increasing numbers of observers in urban areas (Harlequin Duck Working Group 1993). In Alberta, breeding Harlequins are significantly declining on the Maligne River in Jasper National Park (Harlequin Duck Working Group 1993). Seven streams in Northern Idaho appear to be stable, though 1 stream shows a decrease and one shows an increase; all populations are relatively small (Cassirer 1995). In Wyoming, breeding populations appear to be stable in Grand Teton National Park (Harlequin Duck Working Group 1993). In Alaska, a major population in Prince William Sound has been decimated by the *Exxon Valdez* oil spill and the population in the Aleutian Islands also appears to be declining (Harlequin Duck Working Group 1993, Goudie et

al. 1994). The Asian Pacific population appears to be declining rapidly in eastern Siberia (Goudie et al. 1994).

The Atlantic population has undergone and is continuing to undergo significant declines (Harlequin Duck Working Group 1993). Trends in the Greenland and Iceland populations are unknown.

POPULATION REGULATION

A simple model using "guesstimates" for values of survival and fecundity was developed by Goudie and Breault (1994). They estimated that at 85% adult survival, the population would grow at a rate of 6%/year. Simulations indicate that the model was most affected by adult survival; an increase of 3% in mortality may not be sustainable over the long term (Goudie and Breault 1994). Data from Montana does not show anything approaching 85% survival. Even estimating a 10% rate of emigration (which is likely to be quite high), the survival rate would be less than 80%.

CONSERVATION AND MANAGEMENT

IMPLICATIONS OF THE CURRENT RESEARCH

Although much remains to be learned about movements, site fidelity, age-specific reproduction, and survival of Harlequins, what is known about these and other life history parameters shows the precarious nature of the populations in the Rocky Mountains of the U.S. Many items work in tandem to limit the possibilities of recolonization and increase the possibilities for extirpation. These include: 1) high female natal site fidelity; 2) high adult site fidelity; 3) pair bonds developing on the wintering grounds; 4) low levels of movement on the breeding grounds; 5) relatively advanced age at first reproduction; 6) no chance of renesting after about 2 weeks of the start of incubation; 7) low and irregular levels of reproductive success; 8) patches of suitable habitat which are highly fragmented; 9) sensitivity to disturbance; 10) the clumped distribution of pairs even in seemly homogeneous habitat; 10) declining range-wide and regional population levels; 11) relatively small and isolated regional populations; and 12) use of coastal wintering habitat immediately offshore (often less than 100 m).

Harlequins apparently form the pair bond on the coast and the female leads her mate to the breeding stream. Site fidelity is high for both first-time and experienced breeders, probably exceeding 90% for both categories. This leaves very few birds to explore and "pioneer" new sites. It may also be that Harlequin Ducks, like many other birds with clumped distributional patterns such as puffins and Florida Jays, key in on areas with others of the same species present; in other words, good habitat to a "pioneer" is where ducks are already present and empty habitat would be very unlikely to be colonized. Suitable habitat in the Rockies is currently sparse and patches are widely separated. Much has likely been lost and fragmented by development and building of reservoirs.

Small populations on the breeding grounds face several challenges. Random events, such as several birds dying or several poor reproductive years caused by flooding, can dramatically reduce already small populations or eliminate them. Females do not breed until 2 or more years-old and adult success rates may not occur until 4 or more years-old. This means that mortality must be low or few ducks will even make it to breeding age. Once a duck is breeding age, it can only have a single brood each year. While most bird species renest when the nest or young are

lost, there is no possibility of Harlequins renesting after more than a week or two of egg laying, since males return to the coast a week or two after the females begin incubation. The result of the above factors is that reproductive success is low (average 1.38 juvenile per female) and highly variable (annual averages range from 0.13 to 3.15 juvenile per female). An average female is probably at least 5 years-old before she has even raised 2 female ducklings to fledging; it is likely that mortality in the first 6 months following fledging is high.

Harlequins from the U.S. Rocky Mountains move to the Pacific coast off Oregon, Washington, and British Columbia following breeding and remain there until the following spring. They are concentrated in areas with rocky shorelines. Harlequins are the most coastal of wintering seaducks and are thus more susceptible to hunting and oil spills than most seaducks.

This set of facts does not bode well for the 10 occurrences in Montana (of 27 current occurrences not thought to be possibly extirpated) with 1 or 2 pairs of ducks in them. It also shows the critical nature of the 6 occurrences with more than 15 pairs as a source of stability to the Rocky Mountains regional population.

PRIORITIES FOR FUTURE RESEARCH

The following are among the top future research priorities and are primarily a subset of those listed by the Harlequin Duck Working Group (1993) and by Cassirer *et al.* (1996). The Montana Natural Heritage Program has developed research proposals to address the priorities for those questions associated with the breeding grounds and migration and is pursuing funding for them; these are available from the Natural Heritage Program.

1) What are the impacts of human disturbance on breeding and wintering Harlequin Ducks?

Several independent studies have documented the sensitivity of Harlequin Ducks to human disturbance, primarily through the relationship of sighting locations to the accessibility of those locations (Kuchel 1977, Wallen 1987, Diamond and Finnegan 1993, Cassirer and Groves 1991, 1994, Clarkson 1992, Ashley 1994). Specifically, boating has been shown to have a significant negative correlation with numbers of ducks present in one area on a medium-sized stream (Clarkson 1992, Hunt 1993). Observations in other areas tend to support this conclusion (Cassirer and Groves 1991, Brady pers. comm. *in* Clarkson 1992) though it may not be the case in very large streams (Smith 1996). Fishing and human presence have also been suggested as causes of disturbance; however, though specific examples exist for both disturbances, statistical data analyses are lacking (Wallen 1987, McEneaney 1994, Cassirer and Groves 1991).

Other than for boating (Clarkson 1992, Hunt 1993), wide-scale analyses have not yet been attempted nor have analyses of the effects of most specific kinds and amounts of human activities. Several specific studies should be performed to address these questions.

Initially, wide-scale data on Harlequin streams is required, including productivity; population size; length of stream segments used during pair and brood seasons; categories and locations of land ownership of the streams; hydrogeological properties of the streams; habitat characteristics of the streams; and current human use of the stream (by roads, trails, structures, activity, etc.). A first step will be to see which of this information is already available and what is lacking that needs to be gathered in the field. For example, data regarding population size and

length of stream segments used is already in place, while data regarding hydrogeological properties, habitat of the streams, and current human use will require preliminary information gathering to determine what is available. Unused and/or unknown streams that fit physical parameters of used streams can then be selected and compared in respect to kind and amounts of disturbance/accessibility.

Following wide-scale analyses, Harlequin response to humans requires evaluation; initial responses to surveyors could be recorded. Note that this would only provide immediate, in-sight response of birds seen; presumably some birds would react prior to the surveyor seeing them and thus not be observed at all. Nor would such a study reveal length of time or distance moved in reaction to disturbance. A more precise but intrusive method would be to use radiotelemetry on the birds. Radio-telemetry would additionally provide more accurate data on use of habitat types and locations relative to human development/access points.

Finally, when actions are taken on Harlequin streams, monitoring to determine effects of those actions should be implemented, thereby providing for adaptive management and prevention of future mistakes. Specific land management or development actions on Harlequin streams should be proceeded by at least two years of baseline marking and surveying for population size and productivity, areas used at different seasons, habitat evaluation, and pre-action levels of human activity and development. Monitoring should continue to occur during and following the action. Actions which particularly need attention include road, campsite, and trail construction and upgrading, including any increased accessibility and changes in human use of the area; actions which could result in changes to flow regimes or water quality, such as mining, road building, timber harvest, industrial development, and water/hydroelectric development; changes in fishing regulations which could change fishing use of the area; and building of structures such as industrial areas, dams, or houses which will increase the access and use of a Harlequin stream. Possibilities for mitigation and habitat restoration can be explored during these projects.

2) What is the extent and nature of movements in breeding and wintering areas?

This information is needed to determine the possibilities for naturally recolonizing new and historic Harlequin occurrences; naturally supplementing existing occurrences, particularly small populations; and the strength of natal and adult fidelity to particular sites. This information is necessary in order to successfully model Harlequin populations and their stability, with both breeding and wintering grounds data incorporated.

Radio-telemetry may give quick results from the standpoint of local daily movements; however, long distance (>5 km) movements may be relatively rare, and with limited numbers of ducks radioed, may not be best for long distance movement detection. For long distance and moves between years, visibly marking birds is best.

Determining fidelity to natal areas will be a long term project; Montana has the strongest start, with 325 birds banded on the breeding grounds since 1992. Sufficient information for preliminary modeling is now available. Sufficient information for final modeling could be available following the 1998 field season, if funding is continued for the project to that point.

Much data is now available in relation to wintering grounds movements and additional data is currently being collected in Washington, Alaska, and British Columbia. Sufficient information for use in detailed population modeling should be available within 2 years. For an accurate model, information is necessary from both the breeding and wintering grounds.

3) Are distinct metapopulations (such as a Rocky Mountain breeding population) identifiable within the Pacific range of the Harlequin Duck?

A knowledge of the degree of genetic differences among and within wintering and breeding subpopulations would allow an assessment of the appropriate management units for various Harlequin conservation strategies. Dan Esler, Alaska National Biological Service, and Maggie Brown (Department of Wildlife, Fish and Conservation Biology, University of California - Davis) are currently examining this question.

4) What are the critical habitat components limiting Harlequin Duck breeding and wintering populations?

Harlequin Ducks use a wide variety of habitats on the breeding grounds, from forests to tundra. Habitat usage should be documented over a large number of study areas to identify common habitat components for comparison to available habitat; both large and small scale components should be considered.

5) How and why do productivity and survival change over time and different areas, and what are the relative impacts of these changes on populations?

Long term studies are needed to determine population parameters for incorporation into population models (with information from movements on the breeding and wintering grounds). Needed population parameters include: productivity; age-related survival; recruitment; age(s) at first breeding and/or successful breeding; age(s) last breeding; life expectancy; and causes and timing of mortality. This information can only be provided via long-term studies involving marked birds on both the breeding and wintering areas. We are currently in an optimum position to complete studies needed on the breeding grounds, with 5 years of data on the Montana breeding population. Combined with the continued marking and study of coastal populations by Alaska, Washington, Oregon, and British Columbia, many of these parameters may be known by the end of 1998.

The most difficult question to be answered involves the causes of mortality, which is not tractable given current technology. If and when small, long range mortality transmitters are available for ducks, this topic should be pursued.

6) What are the characteristics of Harlequin Duck migration? How well defined are migratory staging areas and migration corridors?

This question may not be tractable given current technology. If and when small, long range mortality transmitters are available for ducks, this topic should be pursued. Some answers may come from large scale marking of individuals, and perhaps by relocating radioed birds.

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Appendices

Appendix A.

Data Forms

Harlequin Duck Survey Form ___ of ___

Date_____ Time_____ Surveyor(s)_____
(Start/Finish)

Stream_____
Include map with exact area(s) surveyed

Begin Point_____ End Pt_____

Water level_____ Survey type: walk auto boat

Weather_____
(Temp., wind dir & speed, cloud cover, precip last 24 hrs)

==========

Group #_____ # Individuals_____

Location_____

Sexes & Ages_____

Marked?_____

Accessibility?_____

Group #_____ # Individuals_____
(Put on map)

Location_____

Sexes & Ages_____

Marked?_____

Accessibility?_____

Group #_____ # Individuals_____
(Put on map)

Location_____

Sexes & Ages_____

Marked?_____

Accessibility?_____

NOTES:

Harlequin Duck Banding Form

Date____________ Stream ____

Exact Location (TRS, utm, etc) ____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt___________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes ____

____

(with other ducks? marked, sex, age? etc.)

+++

Date____________ Stream ____

Exact Location (TRS, utm, etc) ____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt___________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes ____

____

+++

Date____________ Stream ____

Exact Location (TRS, utm, etc) ____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt___________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes ____

____

+++

Date____________ Stream ____

Exact Location (TRS, utm, etc) ____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt___________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes ____

____

+++

NOTES

Date____________ Stream____

Exact Location (TRS, utm, etc)____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt__________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes____

____

(with other ducks? marked, sex, age? etc.)

++

Date____________ Stream____

Exact Location (TRS, utm, etc)____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt__________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes____

____

++

Date____________ Stream____

Exact Location (TRS, utm, etc)____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt__________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes____

____

++

Date____________ Stream____

Exact Location (TRS, utm, etc)____

Sex: M F U **Age:** AD IA IB IC IIA IIB IIC III flying juv

Color Bands Nasal Saddles

Band #__________ Lft________ Rt__________ Lt__________ Rt_________

Weight_________g Wing chord________mm Tail_________mm Tarsus________mm

Notes____

____

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NOTES

HARLEQUIN DUCK OBSERVATION FORM

(Record data for the site where ducks are first seen!)

Date_____ Time_____ Stream_____ Observer_____ Survey/Casual

UTM-N_____ UTM-E_____ T_____ R_____ S_____ 1/4_____

INDIVIDUALS	LEG BANDS (L top/bottom, R top/bottom)	NASAL DISCS (L:R)
1. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
2. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
3. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
4. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
5. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
6. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
7. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
8. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
9. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____
10. Sex__ Age__	__/__ __/__ Legs not seen__ No bands__	_____:_____

ACTIVITY	HABITAT	LOCATION	SUBSTRATE	CHANNEL TYPE
		IS island		
LO loafing	BA backwater	LO loaf	CL clay	ST straight
SW swimming	PO pool	BA bank	SA sand	ME meander
SF swim/feed	RI riffle	ED edge	GR gravel	CU curved
FL flying	GL glide	BT bank 1/3	CO cobble	BR braided
OT other	RU run	CE center	BO boulder	AB abandoned
	RA rapid	EY eddy	BE bedrock	
	PW pocketwater	PD pond		

BANK COMP.	OVERSTORY AGE	HUMAN ACCESS	DEBRIS WITHIN 10m OF DUCK
TR trees	SE seedling	AD adjacent	Loafing sites 0 1 >1 __
SH shrub	SA sapling	NE near	Ramp 0 1 >1 __
GF grass/forb	PO pole	AC accessible	Drift 0 1 >1 __
TS tree/shrub	IM immature	IN inaccessible	Bridge 0 1 >1 __
SA sand	MA mature		Collapsed br. 0 1 >1 __
SI silt	OG old-growth		
GR gravel			
BE bedrock			

Stream depth (m)_____ Bank undercut? Y N Stream velocity:

Stream width (m)_____ Overhanging vegetation? Y N _____ _____ _____

COMMENTS

STREAM HABITAT

Backwater - slow water area out of main stream channel
Pool - deep, slow water area in the stream
Riffle - shallow area where the surface is influenced by the stream bottom
Glide - run area with velocity < 0.3 m/sec
Run - deeper than a riffle, no whitewater, too fast to be a glide or a pool, velocity > 0.3 m/sec
Rapid - whitewater, deep fast water, influenced by stream bottom and/or bank
Pocketwater - a run or riffle with boulders (>30 cm in diameter) which create numerous small pools

LOCATION

Loaf - loafing on a rock or log
Bank - on the streambank
Edge - at the very edge of the stream next to the bank, in the bank eddy
Bank 1/3 - beyond edge but in the third of the stream closest to the bank
Center - in the water in the center 1/3 of the stream, not in an eddy
Eddy - in an eddy created by a rock or a log

SUBSTRATE

Gravel - 0.2-7 cm (0.1-3") diameter
Cobble - 8-30 cm (3-12")
Boulder - >30 cm
Bedrock - no loose fill

CHANNEL TYPE

Straight - Stream channel linear, structurally controlled by a "V" shaped valley, no movement of channel during peak flows
Meander - Channel follows sinuous curves, deep pools seperated by shallow riffles, appears to shift slightly during peak flows
Curved - Stream channel curves or zig-zags more abruptly than a meander, channel structurally controlled by a "V" shaped valley, no movement of channel during peak flows
Braided - Channel located in flat-bottomed valley, midstream bars occur and divide the stream into several intersecting and shifting channels

OVERSTORY AGE

Seedling - 1-10 yrs old, < 4.5' tall
Sapling - 10-40 yrs old, DBH < 5"
Pole - 40-70 yrs old, DBH 5-9"
Immature - 70-100 yrs old, DBH 9-14"
Mature - 100-160 yrs old, DBH 14-20"
Old growth - >160 yrs old, DBH >20"

HUMAN ACCESS

Adjacent - established area of human activity maintained within 10m of bank
Near - established area of human activity maintained within 10-50m of bank
Accessible - >50 m from human activity, accessible by car or trail
Inaccessible - >50 m from human activity, not accessible by car or trail

DEBRIS

Bridge - log across stream
Collapsed bridge - log across stream, collapsed in middle of stream
Ramp - one end of log in stream, other end on the bank
Drift - log in stream that is not close to either bank

LOAFING SITE - rock or log in stream completely surrounded by water, suitable for resting site
VEGETATIVE OVERHANG - vegetation over the stream within 12" of water surface

Appendix B.

Montana Harlequin Duck surveys: 1996

Drainage: Hydrologic Code
Stream

Begin utm			End utm			survey							
zone	east	north	zone	east	north	(m)	Year	Mon	Day	success?	source		

UPPER YELLOWSTONE RIVER DRAINAGE: 100700

Upper Yellowstone River Drainage: 10070002

Mill Creek

12	530650	5021800	12	538190	5013280	13785	1996	7	15	N	Reichel et al. 1997	

CLARK FORK RIVER DRAINAGE: 170102

Rock Creek Drainage: 17010202

Rock Creek, Middle Fork of

12	304670	5100570	12	304230	5096160	4624	1996	5	23	N	Reichel et al. 1997	
12	300560	5102600	12	303780	5104490	4484	1996	8	7	N	Reichel et al. 1997	
12	304670	5100570	12	306900	5105890	8272	1996	8	7	N	Reichel et al. 1997	

Blackfoot River Drainage: 17010203

North Fork Blackfoot River

12	357110	5228500	12	359500	5233000	6084	1996	8	8	Y	Reichel et al. 1997
12	355550	5227050	12	353290	5223810	4752	1996	8	8	N	Reichel et al. 1997

Middle Clark Fork River Drainage: 17010204

Cache Creek

11	680300	5186980	11	673010	5182700	9570	1996	5	22	Y	Reichel et al. 1997
11	673010	5182700	11	680300	5186980	9570	1996	8	6	N	Reichel et al. 1997

Rattlesnake Creek

12	271080	5195430	12	279690	5204410	14950	1996	5	24	N	Reichel et al. 1997
12	284330	5206680	12	279690	5204410	5828	1996	5	25	N	Reichel et al. 1997

Trout Creek

11	663680	5200740	11	652860	5207620	22514	1996	5	21	N	Reichel et al. 1997

North Fork Flathead River: 17010206

Bowman Creek

11	711250	5420780	11	714020	5424000	5650	1996	7	23	N	Reichel et al. 1997

Camas Creek

12	287730	5398870	12	286450	5403600	13529	1996	7	25	N	Reichel et al. 1997

Appendix B (cont). Montana Harlequin Duck surveys 1996.

Drainage: Hydrologic Code / Stream	Begin utm zone	Begin utm east	Begin utm north	End utm zone	End utm east	End utm north	m	Year	mon	day	success?	source
Logging Creek												
	11	706530	5396700	11	708820	5400720	12621	1996	7	24	N	Reichel et al. 1997
Trail Creek												
	11	680510	5422800	11	683364	5423974	3353	1996	5	4	Y	Reichel et al. 1997
	11	687398	5422124	11	683364	5423974	5216	1996	5	4	Y	Reichel et al. 1997
	11	681020	5423200	11	684330	5423270	3772	1996	8	1	Y	Reichel et al. 1997
Middle Fork Flathead River Drainage: 17010207												
Coal Creek												
	12	298290	5366280	12	303800	5365780	7476	1996	6	3	N	Reichel et al. 1997
Harrison Creek												
	12	297000	5378500	12	299310	5380920	3748	1996	7	12	N	Reichel et al. 1997
	12	289450	5374310	12	293790	5376190	6216	1996	7	26	N	Reichel et al. 1997
Ole Creek												
	12	306280	5350720	12	315940	5353250	11719	1996	5	25	N	Reichel et al. 1997
Park Creek												
	12	306230	5353800	12	311200	5355490	7740	1996	7	10	N	Reichel et al. 1997
South Fork Flathead River Drainage: 17010209												
Spotted Bear River												
	12	329160	5310210	12	314530	5312290	19363	1996	7	2	Y	Reichel et al. 1997
	12	321400	5310320	12	331700	5307610	14857	1996	8	3	Y	Reichel et al. 1997
Sullivan Creek												
	12	299720	5324910	12	301450	5316620	12064	1996	6	30	N	Reichel et al. 1997
	12	298200	5322500	12	299720	5324910	3599	1996	8	4	Y	Reichel et al. 1997
Wounded Buck Creek												
	12	282270	5351310	12	280590	5347390	4747	1996	5	20	N	Reichel et al. 1997
Stillwater River Drainage: 17010210												
Grave Creek												
	11	658240	5410430	11	659810	5414900	8346	1996	5	28	N	Reichel et al. 1997
	11	659810	5414900	11	663540	5419680	7997	1996	5	29	Y	Reichel et al. 1997
	11	661350	5417220	11	658780	5411390	7078	1996	7	31	Y	Reichel et al. 1997
	11	664750	5421810	11	661350	5417220	6626	1996	8	1	Y	Reichel et al. 1997
Stillwater River												
	11	665600	5394630	11	666520	5400300	8524	1996	7	7	N	Reichel et al. 1997

Appendix B (cont). Montana Harlequin Duck surveys 1996.

Drainage: Hydrologic Code / Stream	Begin utm			End utm				Date				
	zone	east	north	zone	east	north	m	Year	mon	day	success?	source
Lower Clark Fork River Drainage: 17010213												
Elk Creek, East Fork of												
	11	575680	5313860	11	575370	5317080	3847	1996	7	17	N	Reichel et al. 1997
Marten Creek												
	11	593000	5303250	11	584380	5304140	10200	1996	5	10	Y	Reichel et al. 1997
	11	589150	5304780	11	583900	5303900	5834	1996	6	18	Y	Reichel et al. 1997
	11	584380	5304140	11	589160	5304780	5267	1996	7	3	Y	Reichel et al. 1997
	11	588300	5304830	11	592750	5303120	5672	1996	7	9	N	Reichel et al. 1997
	11	584370	5304140	11	588780	5304790	4730	1996	7	10	Y	Reichel et al. 1997
	11	585180	5304290	11	592750	5303120	9014	1996	7	19	Y	Reichel et al. 1997
	11	592750	5303100	11	592750	5303100	9251	1996	7	29	Y	Reichel et al. 1997
Marten Creek, South Fork												
	11	592910	5303200	11	589710	5299550	5516	1996	5	9	Y	Reichel et al. 1997
	11	592760	5303110	11	590950	5300900	3311	1996	6	17	N	Reichel et al. 1997
	11	592750	5303100	11	589700	5299550	5279	1996	7	2	N	Reichel et al. 1997
	11	590900	5300800	11	592750	5303120	3516	1996	7	19	N	Reichel et al. 1997
Rock Creek												
	11	594930	5314020	11	596430	5319440	7157	1996	5	8	Y	Reichel et al. 1997
	11	596430	5319440	11	594930	5314020	7150	1996	7	4	N	Reichel et al. 1997
	11	597970	5320860	11	594930	5314020	9437	1996	7	18	N	Reichel et al. 1997
Rock Creek, Upper East Fork												
	11	600220	5321780	11	596430	5319440	4967	1996	7	6	N	Reichel et al. 1997
Swamp Creek												
	11	604500	5309500	11	606890	5314220	5746	1996	5	7	Y	Reichel et al. 1997
	11	603120	5307210	11	604520	5309470	2949	1996	5	9	Y	Reichel et al. 1997
	11	604500	5309500	11	606960	5314520	6094	1996	6	19	N	Reichel et al. 1997
	11	606960	5314520	11	603890	5307980	7843	1996	7	5	Y	Reichel et al. 1997
	11	602740	5306430	11	605200	5312000	6731	1996	7	20	Y	Reichel et al. 1997
	11	603890	5307980	11	606890	5314230	7498	1996	7	30	Y	Reichel et al. 1997
Trout Creek												
	11	596840	5295760	11	601610	5298300	7447	1996	7	9	N	Reichel et al. 1997
Vermilion River												
	11	613750	5301290	11	626190	5303080	14900	1996	6	1	N	Reichel et al. 1997
	11	614440	5301250	11	619390	5302810	5959	1996	6	18	Y	Reichel et al. 1997
	11	627100	5296700	11	626300	5303000	7504	1996	7	7	Y	Reichel et al. 1997
	11	626300	5303000	11	623010	5303880	3895	1996	7	8	N	Reichel et al. 1997
	11	620800	5302800	11	613200	5301000	9014	1996	7	16	Y	Reichel et al. 1997
	11	609740	5298670	11	620600	5302850	13923	1996	7	31	Y	Reichel et al. 1997

Appendix C.

Harlequin Ducks observed in 1996

Appendix C. Montana Harlequin Duck observations 1996.

Drainage: Hydrologic Code / Stream	Zone	utm-N	utm-E	Year	Mon	Day	Survey	Pair	M	F	J	Brd	Unk	Observer	Comments	
SASKATCHEWAN RIVER DRAINAGE: 100100																
St. Mary River Drainage: 10010002																
Kennedy Creek	12	5414100	310020	1996	6	12				1				Castren, C.		
MISSOURI RIVER HEADWATERS DRAINAGE: 100200																
Gallatin River Drainage: 10020008																
Gallatin River	12	5032590	481700	1996	5	16		1						Leonard, S.		
UPPER MISSOURI RIVER DRAINAGE: 100301																
Sun River Drainage: 10030104																
Sun River, Gibson Res.	12	5276670	361540	1996	5	28		1						Hamlin, P.		
UPPER YELLOWSTONE RIVER DRAINAGE: 100700																
Clark's Fork of the Yellowstone River Drainage: 10070006																
Rock Creek, Lake Fork	12	4993000	619800	1996	7	5				1				Anon		at Broadwater Lk
	12	4993000	619800	1996	7	11				1				Anon		at Broadwater Lk
	12	4992800	622200	1996	7	31				1	5	1		Anon		at Broadwater Lk
	12	4993000	619800	1996	8	21				1	1	1		Horn, B. and H.	at Broadwater Lk	
	12	4993000	619800	1996	9	6				1	2	1		Cox, Joe	at Broadwater Lk	
	12	4992880	619050	1996	9	12				1	2	1		Keyser, Ed	at Broadwater Lk	
	12	4992580	620920	1996	7	1			1					Reginske, S.		
Rock Creek, West Fork	12	5001500	616000	1996	6	28			1					Huss, T. and Z.		

Appendix C (cont). Montana Harlequin Duck observations 1996.

Drainage: Hydrologic Code / Stream	Zone	utmN	utmE	Year	Mon	Day	Survey	Pair	M	F	J	Brd	Unk	Observer	Comments
KOOTENAI RIVER DRAINAGE: 170101															
Upper Kootenai River Drainage: 17010101															
Grave Creek															
	11	5416020	661010	1996	5	28	MT960344					1			Castren, C.
	11	5418870	663180	1996	5	29	MT960344		1						Castren, C.
	11	5416090	661020	1996	7	31	MT960346					1			Reichel, J. D.
	11	5417880	662820	1996	8	1	MT960347					1	2	1	Reichel, J. D.
CLARK FORK RIVER DRAINAGE: 170102															
Upper Clark Fork River Drainage: 17010201															
Warm Springs Fish Hatchery															
	12	5110600	348800	1996	5	8			1						Skaar, D.
Blackfoot River Drainage: 17010203															
Blackfoot River															
	12	5198200	293100	1996	5	10				1					Gleason, L.
Blackfoot River, North Fork															
	12	5228410	357650	1996	8	8	MT960354					1	2	1	Castren, C.
	12	5228100	355550	1996	8	20								1	Swanberg, T.
Middle Clark Fork River Drainage: 17010204															
Cache Creek															
	11	5186300	679980	1996	5	22	MT960330		1						Hendricks, P.
	11	5183310	674020	1996	5	22	MT960330			2					Castron, C.
	11	5183560	675080	1996	5	22	MT960330			1					Castron, C.
				1996	7	14						1	5	1	Duffalo, B. downy young on S Fork Fish Creek just below Cache Ck
Bitterroot River Drainage: 17010205															
Bitterroot River															
	11	5085600	718200	1996	5	6			3	1					Rowley, Carol

Appendix C (cont). Montana Harlequin Duck observations 1996.

Drainage: Hydrologic Code / Stream	Zone	utmN	utmE	Year	Mon	Day	Survey	Pair	M	F	J	Brd	Unk	Observer		Comments
North Fork Flathead River: 17010206																
Trail Creek																
	11	5423974	683364	1996	5	4	MT960359			2		2				Castren, C.
	11	5423564	684120	1996	5	4	MT960358		2	1						Reichel, J.D.
	11	5423564	683834	1996	5	4	MT960358		1							Reichel, J.D.
	11	5422560	686510	1996	5	4	MT960358			2						Reichel, J.D.
	11	5423490	681380	1996	5	4	MT960359			1						Castren, C.
	11	5423974	683364	1996	5	4	MT960359		1							Castren, C.
	11	5423820	682280	1996	8	1	MT960360					1	3	1		Reichel, J.D.
	11	5423820	682280	1996	8	1	MT960360					1				Reichel, J.D.
South Fork Flathead River Drainage: 17010209																
Spotted Bear River																
	12	5310640	323550	1996	7	2	MT960350					1				Castren, C.
	12	5310210	329160	1996	8	3	MT960351					1	5	1	3	Reichel, J. D.
	12	5308548	330454	1996	8	3	MT960351					1	2	1		Hendricks, P.
	12	5308548	330454	1996	8	3	MT960351					1	6	1		Hendricks, P.
Sullivan Creek																
	12	5323935	299014	1996	8	4	MT960353					1	5	1		Hendricks, P.
Swan River Drainage: 17010212																
Swan River																
	12	5322600	277900	1996	6	7					1					Rumsey, Scott in Swan Lake

Appendix C (cont). Montana Harlequin Duck observations 1996.

Drainage: Hydrologic Code / Stream	Zone	utmN	utmE	Year	Mon	Day	Survey	Pair	M	F	J	Brd	Unk	Observer	Comments	
Lower Clark Fork River Drainage: 17010213																
Marten Creek	11	5304830	588310	1996	5	10	MT960320		1						Castren, C.	
	11	5304830	588310	1996	5	10	MT960320		1						Castren, C.D..	
	11	5304560	586780	1996	5	10	MT960320			3		2			Castren, C.D.	
	11	5304300	585600	1996	6	18	MT960322					1			Castren, C.D..	
	11	5304140	584380	1996	7	3	MT960326					1			Maxell, B.A	
	11	5304800	587550	1996	7	3	MT960326						6	1	Maxell, B.A	
	11	5304800	587550	1996	7	3	MT960326					1	6	1	Maxell, B.A	
	11	5304550	586750	1996	7	3	MT960326					1	3	1	Maxell, B.A	
	11	5304550	586750	1996	7	3	MT960326					1			Maxell, B.A	
	11	5304300	585600	1996	7	10	MT960323					1			Maxell, B.A	
	11	5303120	592750	1996	7	19	MT960306						2	1	Maxell, B.A.	
	11	5304780	589160	1996	7	19	MT960306					1	3	1	Maxell, B.A.	
	11	5303100	592750	1996	7	29	MT960325					1	2	1	Maxell, B.A	
	11	5303100	592750	1996	7	29	MT960325					1	3	1	Maxell, B.A	
	11	5303100	592750	1996	7	29	MT960325					2			Maxell, B.A	
McNeely Creek	11	5300900	590950	1996	5	9	MT960319		1						Castren, C.D.	
Rock Creek	11	5317050	597130	1996	5	8	MT960311		1		1				Castren, C.D.	
	11	5318460	596420	1996	5	8	MT960311		1						Castren, C.D.	
	11	5316050	597000	1996	5	8	MT960311		1						Castren, C.D.	
Swamp Creek				1996	5	7	MT960300				1				Castren, C.D.	
				1996	5	9	MT960301				1				Castren, C.D.	no nasal discs
				1996	7	5	MT960303					1			Maxell, B.A.	no bands, no discs
	11	5313340	606220	1996	7	20	MT960303						5	1	Maxell, B.	
	11	5314230	606890	1996	7	30	MT960305					1	2	1	Castren, C.D.	
Vermillion River	11	5302810	619390	1996	6	18	MT960314					1			Castren, C.D.	
	11	5300800	627200	1996	7	7	MT960317					1			Maxell, B.A.	
	11	5302800	618700	1996	7	16	MT960316					1	9		Maxell, B.A	
	11	5302850	620600	1996	7	31	MT960315					1	7		Castren, C.D.	

Appendix D.

Harlequin Streams in Montana:

Actual, Possible, and Potential

Appendix D, Table 1. Montana harlequin duck breeding and probable breeding occurrences, 1996 (includes those partially or primarily in other states and provinces and historic occurrences).

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Waterton River	B	CB	South Saskatchewan	GNP
includes Kootenai Lakes	PRB		River	
Boundary Creek	PRB			
Olson Creek	B			
Thunderbird Creek	PRB			
Belly River	PRB	U	St. Mary River	GNP
Red Eagle Creek	B	D	St. Mary River	GNP
Roes Creek and Otokomi Lake	B	H	St. Mary River	
St. Mary River (above Lake)	B	C	St. Mary River	GNP
includes St. Mary River	PRB			
Reynolds Creek	B			
Swiftcurrent Creek	B	H	St. Mary River	GNP
Badger Creek	B	CB	South Marias River	LCNF
includes North Badger Creek	B			
South Badger Creek	B			
Birch Creek	B	CB	South Marias River	LCNF
includes Birch Creek	PRB			
North Fork Birch Creek	PRB			
Middle Fork Birch Creek	PRB			
South Fork Birch Creek	B			
South Fork Two Medicine River	B	D	South Marias River	LCNF
includes Summit Creek	BU			
Two Medicine River	PRB	D	South Marias River	GNP,
includes Paradise Creek	PRB			BIR
Dry Fork Creek	BU			
North Fork Teton River	B	DC	Teton River	LCNF

Appendix D, Table 1, cont. Montana harlequin duck breeding and probable breeding occurrences, 1996 (includes those partially or primarily in other states and provinces and historic occurrences).

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Sun River	B	BA	Sun River	LCNF
includes Sun River	BU			
North Fork Sun River	B			
Biggs Creek	BU			
Moose Creek	B			
South Fork Sun River	B			
Straight Creek	B			
West Fork Sun River	B			
Ahorn Creek	B			
Woods Creek	BU			
Boulder River	B	CB	Yellowstone River	GNF
Yellowstone River	B	AB	Yellowstone River	YNP
includes Hellroaring Creek	B			
Tower Creek	B			
Lamar River	PRB			
Soda Butte Creek	B			
Gardner River	PRB			
Lake Fork Rock Creek	B	DC	Clarks Fork Yellowstone	CNF
West Fork Stillwater	B	F	Yellowstone River	CNF
Bighorn River	PRB	X	Yellowstone River	BCNRA
Big Creek	B	F	Kootenai River	KNF
Callahan Creek	B	D	Kootenai River	KNF
includes Callahan Creek	BU			
North Fork Callahan Creek	B			
Grave Creek	B	C	Kootenai River	KNF
Kootenai Falls	B	X	Kootenai River	KNF
Quartz Creek	B	D	Kootenai River	KNF
Wigwam River	PRB	U	Kootenai River	KNF
West Fork Yaak River	B	DC	Yaak River	KNF
Middle Fork Rock Creek	B	DC	Rock Creek	DNF
Big Creek	PRB	D	N. Fork Flathead R.	FNF

Appendix D, Table 1, cont. Montana harlequin duck breeding and probable breeding occurrences, 1996 (includes those partially or primarily in other states and provinces and historic occurrences).

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Trail Creek	B	BC	North Fork Flathead River	GNP, FNF
Includes Kishenehn Creek	B			
Upper N. Fork Flathead River	B			
McDonald Creek	B	AB	Middle Fork Flathead River	GNP, FNF
includes Avalanche Creek	B			
Mineral Creek	B			
Snyder Creek	PRB			
Sprague Creek	BU			
Fish Creek	PRB			
Middle Fork Flathead R. (lower)	B			
Middle Fork Flathead River	B	CD	Middle Fork Flathead River	FNF, GNP
includes Bear Creek	BU			
Ole Creek	BU			
Upper South Fork Flathead River	B	BC	South Fork Flathead River	FNF
includes White River	B			
Little Salmon Creek	B			
Spotted Bear River	B	CD	South Fork Flathead River	FNF
Sullivan Creek	B	D	South Fork Flathead River	FNF
Wounded Buck Creek	B	F	South Fork Flathead River	FNF
Swift Creek	PRB	DC	Stillwater River (north)	MTSL
North Fork Blackfoot River	B	C	Blackfoot River	LNF
includes Dry Fork N. F. Blackfoot	BU			
East Fork North Fork Blackfoot	BU			
Rattlesnake Creek	PRB	F	Middle Clark Fork	LNF
Cache Creek	B	DC	Middle Clark Fork	LNF
includes Cache Creek	PRB			
South Fork Fish Creek	B			
Trout Creek	B	F	Middle Clark Fork	LNF

Appendix D, Table 1, cont. Montana harlequin duck breeding and probable breeding occurrences, 1996 (includes those partially or primarily in other states and provinces and historic occurrences).

Occurrence	Status[1]	Rank[2]	Watershed	Primary ownership[3]
Elk Creek	PRB	D	Lower Clark Fork	KNF
Noxon	B	BA	Lower Clark Fork	KNF
includes Marten Creek	B			
South Fork Marten Creek	B			
South Branch Marten Creek	BU			
McNeeley Creek	BU			
Rock Creek	B			
East Fork Rock	BU			
West Fork Rock	BU			
Swamp Creek	B			
Vermilion River	B			

[1] B = Breeding, PRB = Probable breeding, BU = Breeding status unknown.

[2] A = 20+ pairs within a single occurrence. B = 5 - 19 pairs within the occurrence and a minimum of 10 pairs within the occurrence and other occurrences within 40 km. C = 3+ pairs within the occurrence; if 5+ pairs then < 10 pairs within the occurrence and other occurrences within 40 km. D = 1-2 pairs. U = Unknown: not enough data to place in a range of 2 categories. H = Historic, may be rediscovered. F=Failed to find in most recent surveys. X = Extirpated from site.

[3] BCNRA = Bighorn Canyon National Recreation Area, BIR = Blackfeet Indian Reservation, CNF = Custer National Forest, DNF = Deerlodge National Forest, FNF = Flathead National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis and Clark National Forest, LNF = Lolo National Forest, MTSL= Montana Dept. of State Lands, YNP = Yellowstone National Park.

Appendix D, Table 2. Montana streams where harlequin ducks have been observed or reported, but current breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Otatso Creek includes Slide Lake	St. Mary River	GNP	1
Cut Bank Creek	Cut Bank Creek	BIR	0
South Fork Teton River	Teton River	LCNF	3
Upper Madison River	Madison River	GNF	0
Elk Creek includes East Fork Elk Creek West Fork Elk Creek	Upper Yellowstone River	GNF	1
Mill Creek	Upper Yellowstone River	GNF	1
Sweet Grass Creek	Upper Yellowstone River	GNF	0
Rock Creek includes West Fork Rock Creek	Clarks Forks Yellowstone	CNF	0
Lake Creek	Kootenai River	KNF	1
Seventeenmile Creek	Yaak River	KNF	5
Clearwater River	Blackfoot River	LNF	0
Willow Creek	Blackfoot River	HNF	0
Twelvemile Creek	Middle Clark Fork	LNF	2
North Fork Flathead River (south of Trail Creek)	North Fork Flathead River	GNP, FNF	5
Red Meadow Creek	North Fork Flathead R.	FNF	3
Whale Creek	North Fork Flathead R.	FNF	5

Appendix D, Table 2, cont. Montana streams where harlequin ducks have been observed or reported, but current breeding status is unknown.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Starvation Creek	North Fork Flathead R.	GNP	0
Middle Fork Flathead River sections between and above known sites	Middle Fork Flathead R.	GNP, FNF	3
Granite Creek	Middle Fork Flathead R.	FNF	0
Lincoln Creek	Middle Fork Flathead R.	GNP	1
Nyack Creek	Middle Fork Flathead R.	GNP	0
Bunker Creek	South Fork Flathead R.	FNF	5
South Fork Flathead River includes sections above reservoir not included in Appendix B, Table 1.	South Fork Flathead R.	FNF	5
Jocko River	Lower Flathead River	FIR	0
Stillwater River	Stillwater River (northern)	MDSL KNF	4
Bull River upper stretches of major forks	Lower Clark Fork	KNF	1-3
Deep Creek	Lower Clark Fork	LNF	0
Fishtrap Creek	Lower Clark Fork	LNF	5
Graves Creek	Lower Clark Fork	LNF	9
White Pine Creek	Lower Clark Fork	KNF	1

[1] BIR = Blackfeet Indian Reservation, BNF = Bitterroot National Forest, CNF = Custer National Forest, FNF = Flathead National Forest, GNF= Gallatin National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis Clark National Forest, LNF = Lolo National Forest.

Appendix D. Table 3. Partial list of potential harlequin duck breeding streams in Montana.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Sherburne River	St. Mary River	GNP	0
Middle Fork Teton River	Teton River	LCNF	0
Pattengail Creek	Wise River	BNF	0
West Fork Madison River	Madison River	GNF	1
Taylor Fork Gallatin River	Gallatin River	GNF	1
Upper Boulder River	Boulder River	DNF	0
Milk River (upper forks)	Milk River	BIR	0
West Fork Teton River	Teton River	LCNF	1
Dearborn River (& forks)	Dearborn/Missouri Rivers	LCNF	3
Forks of Boulder River	Upper Yellowstone River	GNF	2-4
Hellroaring Creek	Upper Yellowstone River	GNF	0
Slough Creek	Upper Yellowstone River	GNF	0
Big Creek	Upper Yellowstone River	GNF	1
Rock Creek	Upper Yellowstone River	GNF	0
Rosebud Creek	Stillwater River (south)	CNF	2
Stillwater River (& forks)	Stillwater River (south)	CNF	4
South Fork Callahan Creek	Kootenai River	KNF	4
Keeler Creek	Kootenai River	KNF	2
Fish Creek (& forks)	Middle Clark Fork River	LNF	0
Anaconda Creek	North Fork Flathead River	GNP	0
Bowman Creek	North Fork Flathead River	GNP	1
Camas Creek	North Fork Flathead River	GNP	1
Kintla Creek	North Fork Flathead River	GNP	2

[1] BIR = Blackfeet Indian Reservation, BNF = Bitterroot National Forest, CNF = Custer National Forest, FNF = Flathead National Forest, GNF= Gallatin National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest, LCNF = Lewis Clark National Forest, LNF = Lolo National Forest.

Appendix D. Table 3, cont. Partial list of potential harlequin duck breeding streams in Montana.

Stream	Watershed	Primary ownership[1]	No. surveys conducted
Quartz Creek	North Fork Flathead River	GNP	0
Coal Creek	Middle Fork Flathead River	GNP	0
Dolly Varden Creek	Middle Fork Flathead River	FNF	2
Morrison Creek	Middle Fork Flathead River	FNF	1
Park Creek	Middle Fork Flathead River	GNP	0
Schafer Creek	Middle Fork Flathead River	FNF	2
Bunker Creek	South Fork Flathead River	FNF	5
Trout Creek	Lower Clark Fork River	KNF	3

[1] FNF = Flathead National Forest, GNP = Glacier National Park, KNF = Kootenai National Forest.

Appendix E.

Harlequin Duck numbers in each occurrence for Montana

Appendix E. Montana harlequin duck numbers in each occurrence.

Occurrence	Maximum # pairs/females seen on a single survey	Minimum # of pairs present in max. year[1]	Correction Factor	Estimated # of pairs present[2]	
Waterton River					14
includes Waterton River/Kootenai Lakes	8	8	.72	11	
Boundary Creek	-	1	.72	1	
Olson Creek	-	1	.72	1	
St. Mary River (above Lake)					8
includes St. Mary River	3	3	.72	4	
Reynolds Creek	1	2	.72	3	
Red Eagle Creek		1	.72	1	
Rose Creek and Otokomi Lake	0	0	.72	0	
Belly River		1	.72	1	1
Badger Creek					17
includes Badger Creek	3	3	.72	4	
North Badger Creek	6	6	.72	8	
South Badger Creek	3	3	.72	4	
Swiftcurrent Creek					
Birch Creek					10
includes Birch Creek & Swift Reservoir	2	2	.72	3	
North Fork Birch Creek	1	1	.72	1	
Middle Fork Birch Creek	1	1	.72	1	
South Fork Birch Creek	3	3	.72	4	
South Fork Two Medicine River					1
includes S. Fork Two Medicine River	1	1	.72	1	
Summit Creek	0	0	.72	0	

[1] The least number of pairs present in the year with the highest survey number, except when the occurrence may be extirpated; then the number is 0.

[2] Total estimated pairs in multi-stream occurrences may not equal the sum of the streams because, while the numbers are shown as integers, the exact numbers are used in calculations.

Appendix E. Montana harlequin duck numbers in each occurrence.

Occurrence	Maximum # pairs/females seen on a single survey	Minimum # of pairs present in max. year[1]	Correction Factor	Estimated # of pairs present[2]	
Two Medicine River					2
includes Two Medicine River	0	0	.72	0	
Dry Fork Creek	1	1	.72	1	
Paradise Creek	1	1	.72	1	
North Fork Teton River	1	1	.72	1	1
Sun River					24
includes Sun River	0	0	.72	0	
North Fork Sun River	2	2	.72	3	
Moose Creek	1	1	.72	1	
South Fork Sun River	6	6	.72	8	
Straight Creek	2	2	.72	3	
West Fork Sun River	4	4	.72	6	
Ahorn Creek	1	1	.72	1	
Woods Creek	1	1	.72	1	
Yellowstone River					
Boulder River	4	4	.72	6	6
Lake Fork Rock Creek	2	2	.72	3	3
Big Creek (Koocanusa)	0	0	.72	0	0
Callahan Creek					3
includes Callahan Creek	1	1	.72	1	
North Callahan Creek	1	1	.72	1	
Grave Creek	5	5	.72	7	7
Kootenai Falls	0	0	.72	0	0
Quartz Creek	0	0	.72	0	0
Wigwam River	0	0	.72	0	0

[1] The least number of pairs present in the year with the highest survey number, except when the occurrence may be extirpated; then the number is 0.

[2] Total estimated pairs in multi-stream occurrences may not equal the sum of the streams because, while the numbers are shown as integers, the exact numbers are used in calculations.

Appendix E. Montana harlequin duck numbers in each occurrence.

Occurrence	Maximum # pairs/females seen on a single survey	Minimum # of pairs present in max. year[1]	Correction Factor	Estimated # of pairs present[2]	
West Fork Yaak River	1	1	.72	1	1
Big Creek (N.F. Flathead)	1	1	.72	1	1
Upper North Fork Flathead River					8
Includes Kishenehn Creek	0	1	.72	1	
North Fork Flathead River	0	0	.72	0	
Trail Creek	6	6	.90	7	
McDonald Creek					41
includes McDonald Creek to Logan Ck	14	21	.90	23	
McDonald Ck above Logan Ck	3	3	.72	4	
Avalanche Creek	2	2	.72	3	
Mineral Creek	1	1	.72	1	
Snyder Creek	2	2	.72	3	
Sprague Creek	2	2	.72	3	
Fish Creek	2	2	.72	3	
Middle Fork Flathead R. (lower)	0	1	.72	1	
Middle Fork Flathead River					6
includes Middle Fork Flathead River	2	2	.72	3	
Bear Creek	0	1	.72	1	
Ole Creek	0	1	.72	1	
Upper South Fork Flathead River					14
includes Upper S. F. Flathead	4	4	.72	6	
White River	4	4	.72	6	
Little Salmon Creek	2	2	.72	3	
Spotted Bear River	4	4	.72	6	6
Sullivan Creek	2	2	.72	3	3

[1] The least number of pairs present in the year with the highest survey number, except when the occurrence may be extirpated; then the number is 0.

[2] Total estimated pairs in multi-stream occurrences may not equal the sum of the streams because, while the numbers are shown as integers, the exact numbers are used in calculations.

Appendix E. Montana harlequin duck numbers in each occurrence.

Occurrence	Maximum # pairs/females seen on a single survey	Minimum # of pairs present in max. year[1]	Correction Factor	Estimated # of pairs present[2]	
Wounded Buck Creek	1	1	.72	1	1
Swift Creek	1	1	.72	1	1
North Fork Blackfoot River					8
includes North Fork Blackfoot	4	4	.72	6	
Dry Fork of N. F. Blackfoot	0	1	.72	1	
E. Fork North Fork Blackfoot	1	1	.72	1	
Middle Fork Rock Creek	0	1	.72	1	1
Rattlesnake Creek	0	0	.72	0	0
Cache Creek	1	1	.72	1	1
Trout Creek	2	0	.72	0	0
Elk Creek	0	1	.72	1	1
Noxon					17
includes Marten Creek	5	5	.90	6	
Rock Creek	3	4	.90	4	
Swamp Creek	3	3	.90	3	
Vermilion River	3	3	.90	3	
TOTAL		159			209

[1] The least number of pairs present in the year with the highest survey number, except when the occurrence may be extirpated; then the number is 0.

[2] Total estimated pairs in multi-stream occurrences may not equal the sum of the streams because, while the numbers are shown as integers, the exact numbers are used in calculations.

Appendix F.

Characteristics of Harlequin Duck occurrences in Montana

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
1	**Boulder River**	33451			714	1.69%	6	0.179
1	Boulder River	24137	6688	5340	408			
1	East Fk Boulder River	8037	7555	6548	305			
1	South Fk Boulder River	1277			0			
2	**McDonald Creek**	51034			1104	2.16%	41	0.803
2	Avalanche Creek	3636	4320	3408	276			
2	Fern Creek	377	3315	3230	26			
2	Fish Creek	1970	3409	3160	75			
2	M Fk Flathead River (lower)	6656	3220	3160	18			
2	McDonald Creek	30265	4320	3153	354			
2	McDonald Creek (lower)	3638			0			
2	Mineral Creek	1133	4360	4280	24			
2	Snyder Creek	1420	3580	3160	127			
2	Sprague Creek	1469	3830	3160	203			
2	Sprague Creek (S branch)	470			0			
3	**Sun River**	112254			1204	1.07%	24	0.214
3	Ahorn Creek	4909	5585	5300	86			
3	Biggs Creek	2102	5200	5010	58			
3	Moose Creek	10304	5540	5000	164			
3	N Fk Sun River	14821	5410	4725	208			
3	S Fk Sun River	44123	5585	4725	261			
3	Straight Creek	12780	5720	5208	155			

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
3	W Fk S Fk Sun River	23215	5880	4980	273			
4	**Greater Lower Clark Fork**	68799			1472	2.14%	17	0.247
5	Rock Creek (Noxon)	13178	3785	2330	441			
5	West Fk Rock Creek	1569	3080	2760	97			
6	Marten Creek	12367	3190	2350	255			
6	S Fk Marten Creek	4153	2615	2350	80			
11	Swamp Creek	14349	3448	2450	302			
8	Vermilion River	23183	3330	2350	297			
7	**Badger Creek**	29890			471	1.57%	17	0.569
7	Badger Creek	10730	4900	4660	73			
7	North Badger Creek	10704	5695	4900	241			
7	South Badger Creek	8456	5418	4900	157			
9	**S Fk Two Medicine River**	9390			73	0.77%	1	0.106
9	S Fk Two Medicine River	8582	5080	4840	73			
9	Summit Creek	808			0			
10	**Trout Creek**	9271	3490	2975	156	1.68%		
12	**Kootenai River**	2148	1920	1828	28	1.30%		
13	**Wounded Buck Creek**	3095	4295	3585	215	6.95%		

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
16	**Birch Creek**	24723			692	2.80%	10	0.404
16	Middle Fk Birch Creek	6625	5712	5040	204			
16	North Fork Birch Creek	7971	5550	4800	227			
16	South Fork Birch Creek	10127	5660	4800	261			
17	**Sullivan Creek**	11706	4115	3590	159	1.36%	3	0.256
18	**Middle Fork Flathead River**	33656	4200	3670	161	0.48%	6	0.178
19	**Greater North Fork Flathead**	54743			288	0.53%	8	0.146
19	Kishenehn Creek	8370	4105	3869	72			
19	N Fk Flathead River	33012	3869	3600	82			
19	Trail Creek	13361	4275	3830	135			
20	**Big Creek (N.F. Flathead)**	15019	3350	3114	72	0.48%	1	0.067
21	**Callahan Creek**	13393			318	2.38%	3	0.224
21	Callahan Creek	9581	2706	2000	214			
21	North Callahan Creek	3812	3051	2706	105			
22	**N Fk Blackfoot River**	26168			416	1.59%	8	0.306
22	Dry Fork N Fk Blackfoot	4007	5115	5040	23			
22	East Fk N Fk Blackfoot	857	5520	5430	27			
22	N Fk Blackfoot River	21304	5928	4720	366			

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
25	**Greater Waterton**	21090			534	2.53%	14	0.664
25	Boundary Creek	4293	4800	4196	183			
25	Olson Creek	9453	5255	4300	289			
25	Waterton River	7344	4400	4196	62			
27	**Roes Creek**	913	6505	6482	7	0.76%		
29	**Spotted Bear River**	34013	4852	3785	323	0.95%	6	0.176
30	**Rattlesnake Creek**	24604	5025	3443	479	1.95%		
31	**Red Eagle Creek**	4851			340	7.02%	1	0.206
31	Hudson Bay Creek	2443	5590	4800	239			
31	Red Eagle Creek	2408	5055	4722	101			
32	**Teton River**	31543			425	1.35%	1	0.032
32	N Fk Teton River	19331	5550	4840	215			
32	S Fk Teton River	12212	5533	4840	210			
33	**Grave Creek**	26439	4508	2800	518	1.96%	7	0.265
34	**Greater S Fk Flathead River**	30790			283	0.92%	14	0.455
34	Little Salmon Creek	4364	4295	4200	29			

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
34	S Fk Flathead River	13478	4415	4200	65			
34	White River	12948	4985	4360	189			
35	**Quartz Creek**	1128	2150	2070	24	2.15%		
36	**Greater Saint Mary River**	14532			350	2.41%	7	0.482
36	Reynolds Creek	2266	5140	4700	133			
36	Saint Mary River	12266	5200	4484	217			
37	**Big Creek (Koocanusa)**	14084	3885	3340	165	1.17%		
38	**East Fk Elk Creek**	10189	3080	2410	203	1.99%	1	0.098
41	**Greater Rock Creek (Red Lodge)**	17896			411	2.29%	3	0.168
41	Lake Fork Rock Creek	13106	8585	7760	250			
41	Rock Creek	4790	7210	6680	161			

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
42	**Greater Yellowstone River**	142011			1693	1.19%	???	
42	Gardner River	9036	5840	5240	182			
42	Hellroaring Creek	8708	6288	5720	172			
42	Lamar River	22644	6583	6000	177			
42	Pelican Creek	635	7880	7781	30			
42	Soda Butte Creek	4074	6655	6583	22			
42	Tower Creek	1518	6560	5240	400			
42	Yellowstone River	95396	7744	5400	710			
43	**W Fk Yaak River**	1835	3388	3275	34	1.87%	1	0.545
45	**Swift Creek**	22637	4148	3085	322	1.42%	1	0.044
46	**Greater Belly River**	21466			435	2.03%	1	0.047
46	Belly River	15080	4890	4600	88			
46	Kaina Creek	1045	5070	4852	66			
46	Mokowanis River	2975	4885	4655	70			
46	Pyramid Creek	2366	5560	4862	212			
47	**Swiftcurrent Creek**	3207	5070	4800	82	2.55%	1	0.312
48	**Greater Two Medicine Creek**	10125			499	4.93%	2	0.198
48	Aster Creek	877	6260	5164	332			
48	Paradise Creek	2592	5470	5200	82			

Appendix F. Characteristics of Harlequin Duck occurrences in Montana.

EONUM	Occurrence Stream	length (meters)	upper elevation (feet)	lower elevation (feet)	elevation change (meters)	gradient	# pairs	# pairs per km
48	Two Medicine Creek	6656	5164	4882	85			
	TOTAL OCCUPIED	627867			10428	1.66%	205	0.327